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Abstract

This report describes the development of the Project ABLE Power Mechanics program. It is designed to serve as an administrator's and instructor's manual for the organization, implementation and evaluation of a program of individualized instruction utilizing the Project ABLE Power Mechanics Curriculum materials. Training aids, tools, supplies, and references are listed in detail. Major documents and samples of instruments, performance evaluations, learning units, flow charts, first and second level job descriptions, and suggested first level student activities are appended. Earlier reports (1-11) are available as ED 024 749-ED 024 754, ED 024 767, ED 028 306, ED 013 318, and ED 029 088. (GR)

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DEVELOPMENT AND EVALUATION OF AN EXPERIMENTAL CURRICULUM FOR THE NEW QUINCY (MASS.) VOCATIONAL-TECHNICAL SCHOOL

The Power Mechanics Curriculum

July 1969

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

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The Power Mechanics Curriculum

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J. William Ullery
Richard W. Forsyth

July 1969

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Quincy, Massachusetts

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FOREWORD

This report is intended to serve a number of purposes:

(1) The contract obligates the Project staff to submit to USOE, technical reports on a quarterly basis.

(2) The contract obligates the Project staff to disseminate its curriculum products.

(3) In addition, this report is intended to serve as an instructor's and administrator's manual for the organization, implementation, operation, and evaluation of a program of individualized instruction utilizing the Project ABLE Power Mechanics curriculum materials. The detailed descriptions offered in this report should also enable instructors to prepare supplementary materials more appropriate to the situational requirements of a particular school.

(4) The report should also document the need for evaluation and validation on a population of adequate size in varied settings and geographic areas.

The title of the Project identifies the major goal as the "Development and Evaluation of an Experimental Curriculum...". This report will focus primarily on the developmental activities in one area--Power Mechanics. Evaluation and validation, in one sense, cannot take place until there are graduates of the program working in the job family for which they were trained. Evaluation and validation, in another sense, must be a part of the developmental process from the very beginning. An attempt will be made to describe such activity and then to make recommendations upon which action must be taken if the process is to continue.

Appendix A includes a flow chart which illustrates the process that was to have been followed in the development and evaluation of curricula for Project ABLE. The second chart, in the opinion of the authors, provides a model for a more rigorous application of "systems" concepts. The Power Mechanics staff attempted to use such procedures. The model flow chart, however, was prepared as a guide for new development which would result in a single set of self-paced curriculum materials (e.g. programmed) as the major vehicle of instruction. On the other hand, the ABLE Power Mechanics program includes a variety of references and optional activities for meeting behaviorally stated course objectives. Therefore, some practical modifications have been exercised. The third chart represents a systematic process which was found to be functional and economical for several Project ABLE programs.

ACKNOWLEDGMENT

Many persons, including students, have been involved in the design and development of the curriculum products described in this report. Mr. Richard W. Forsyth, a Quincy vocational instructor, participated in the testing of the materials with two classes of tenth grade students. He also served as a member of the systems development team in the role of a content expert. The extent of his involvement in the editing and revision of curriculum materials during the summer of 1969 has qualified Mr. Forsyth as a co-author. Mr. Anthony Rizzotti, a Quincy vocational instructor, assisted in the job and task analysis. Mr. Leonello Pellegrini, also a vocational school instructor, assisted in the testing of materials. His primary duties were the development of training aids, mock-ups, and shop development required to support the learning activities. Two other Quincy instructors, Mr. D. Edwin Cain and Mr. Charles Magnarelli, participated in some early development. It should be noted that the instructors were tradesmen in their teaching area and considered experts in the content area. Two AIR learning psychologists, Mr. Boyd Kowal and Miss Vivian Hudak, served as consultants during the initial development. Mr. Glen E. Neifing, an AIR research staff member, has served as a consultant. The director and principal developer has been Mr. J. William Ullery, an AIR research scientist.

Many other workers and key administrative personnel of both Quincy and AIR have been involved and have contributed in many ways through services, assistance and guidance. An honorable mention must also be given the two fine Project ABLE secretaries, Mrs. Nancy Knudsen and Mrs. Barbara Colp, who labored over the learning materials and reports with conscientious dedication.

OVERVIEW: Project ABLE

A Joint Research Project of: Public Schools of Quincy, Massachusetts and American Institutes for Research

Title: DEVELOPMENT AND EVALUATION OF AN EXPERIMENTAL CURRICULUM FOR THE NEW QUINCY (MASS.) VOCATIONAL-TECHNICAL SCHOOL

Objectives: The principal goal of the project is to demonstrate increased effectiveness of instruction whose content is explicitly derived from analysis of desired behavior after graduation and which in addition attempts to apply newly developed educational technology to the design, conduct, and evaluation of vocational education. Included in this new technology are methods of defining educational objectives, deriving topical content for courses, preparation of students in prerequisite knowledges and attitudes, individualizing instruction, measuring student achievement, and establishing a system for evaluating program results in terms of outcomes following graduation.

Procedure: The procedure begins with the collection of vocational information for representative jobs in eleven different vocational areas. Analysis will then be made of the performances required for job execution, resulting in descriptions of essential classes of performance which need to be learned. On the basis of this information, a panel of educational and vocational scholars will develop recommended objectives for a vocational curriculum which incorporates the goals of (1) vocational competence; (2) responsible citizenship; and (3) individual self-fulfillment. A curriculum will then be designed in topic form to provide for comprehensiveness and also flexibility of coverage for each of the vocational areas. Guidance programs and prerequisite instruction to prepare junior high students will also be designed. Selection of instructional materials, methods, and aids, and design of materials, when required, will also be undertaken. An important step will be the development of performance measures tied to the objectives of instruction. Methods of instruction will be devised to make possible individualized student progression and selection of alternative programs, and teacher-training materials will be developed to accomplish inservice teacher education of Quincy School personnel. A plan will be developed for conducting program evaluation not only in terms of end-of-year examinations, but also in terms of continuing follow-up of outcomes after graduation.

REPORT SUMMARY

This report describes the development of the Project ABLE Power Mechanics program. A brief review of the goals and objectives of the Project is included along with a rationale for the Power Mechanics curriculum.

The process was initiated by a careful analysis of occupations which formed what is termed a job family. The occupations were analyzed for common skills and knowledges. Also considered were job requirements, conditions, trends, and other factors. The jobs were then categorized and ranked by hierarchies of skills and knowledges. Training vehicles or representative jobs were then identified and a flow chart for the job family developed. Job descriptions and task enumerations were followed by a task analysis. Behaviorally stated objectives derived from the task analysis were translated into criterion tests called performance evaluations. Highly structured learning units were also developed to facilitate the implementation of a program of individualized instruction.

Major documents and samples of instruments, performance evaluations, learning units, and other materials are included in the report. A description of the initial procedures used in testing and revising, along with appropriate data, is provided. The report will serve as an administrator's and instructor's manual for institutions wishing to test the program. For this purpose, information is included for the organization, implementation and evaluation of the program. Training aids, tools, supplies, references, and items that are similar, are listed in detail.

INTRODUCTION

The principal goal of Project ABLE is to demonstrate increased effectiveness of instruction that derives content from explicit analysis of desired behavior after graduation. Rather than taking a total body of knowledge and drawing content from it, each curriculum is defined by what technology and industry need for job success. Subordinate objectives embodied in this plan are the following:

(1) Development of educational objectives. The intent here is to identify the behaviors which are desired of the student when he has completed a particular course of instruction. Education has no meaning in the abstract--objectives need to be stated in specific operational terms. While emphasizing the vocational area of educational goals, the goals include the development of individual attitudes toward work, habits of work, and standards of excellence.

(2) Derivation of curriculum requirements. Curriculum needs are described in terms of topics within each "subject" and are placed in an instructional sequence which takes prerequisite knowledges systematically into account. Each learning sequence is in the curriculum because it must be there if the student is to be competent and the justification for its presence can be demonstrated on the basis of relevance to a vocationally-oriented educational goal. Project ABLE, by analyzing the requirements of many jobs within each vocational area for common and related skills, attempts to provide education in the skills and knowledges which are common to a variety of occupations. This should minimize the amount of "new" training that might result from job change or because of opportunities opening up in related areas. This should also provide the flexibility needed to accomodate to changes in demands of the technology.

(3) Description of needs for prerequisite learning. The elaboration of a new curriculum is intended to make possible the specification of prerequisite knowledges to be acquired in junior high years of schooling, including the kinds of student prepara-

tion which might be gained in industrial arts and other basic areas of instruction. The aim is the development of broad exploratory programs in the junior high grades to prepare students for productive educational and vocational careers.

(4) Effecting changes in student viewpoints. A most difficult task facing any student and his family is that of choosing realistic life goals and the educational path to those goals. The pressures of our society have been directed toward college attendance, while trade school courses have often been relegated to second-class status. Project ABLE includes preparation of an organized program for assessing each student's abilities and interests and for helping him and his family evaluate them over a wide range of occupations. This involves the inservice training of junior high school guidance counselors and the provision of materials and information for junior high students.

(5) Individualizing instruction. It has been demonstrated repeatedly that individuals differ with respect to their abilities. The traditional classroom has not made sufficient provision for these individual differences, but with increasing frequency, especially at the elementary level, schools are changing to individualized study programs. Project ABLE incorporates the concepts of individualized instruction by providing a framework which will allow for maximum flexibility of student progression through a course. Learning is a process guided by the teacher, rather than by forcing facts into students. A student's achievement is the standard of his learning progress, and, at the same time, a primary source of his motivation. The student is given a set of objectives which tell him all the things he is expected to be able to do after completing an assignment. The key feature is, however, that students do the learning largely on their own and student-teacher interactions are not restricted to lectures and group demonstrations.

(6) Student evaluation. Appropriately derived topic objectives lead directly to measures of student performance. It is desired here that all "units" of instruction have performance measures which are available to the student, to instructors, and

to guidance counselors. These proficiency tests are an essential and integral part of individualized instruction, and they contribute to making the student evaluation file a clear history of learning achievement. Emphasis in this testing is on attainment of goals, rather than upon differentiation of students into "good" or "bad", and to provide directions for future effort on the part of the student.

(7) Program evaluation. A comprehensive program of evaluation includes objective measures of immediate outcomes, as well as the foundation of techniques for the later collection of follow-up data on educational outcomes after graduation. Student evaluations yield many of the basic data for program evaluation; this requires systematic recording and storing of indicators of student experience and performance. A second feature is establishment of techniques for following up the student at periodic intervals to collect information on employment, job success, and career progression at intervals after graduation. Systematic information of this sort will constitute the basis for program evaluation in terms of its long-range effects.

The curriculum described in this report is intended to provide general vocational competence within one specific family area. A vocational area behavioral analysis approach to specification of course and topic objectives stated in terms of performances required for job execution distinguishes the learnable skills and knowledges generalizable across several jobs within the occupational group. Given training in those skills and knowledges common to a variety of occupations, the student-graduate should have a greater flexibility in shifting with changes in industry. There is opportunity for increasing specialization, but it is built upon a broad base of more general competence within the vocational area.

The development includes a planned set of training levels of specific education within each area, requiring a range of preparation times designated by jobs (or job clusters). The domain of jobs in an occupational group has been structured to reflect the progression of skills inherent in those jobs. Selection of jobs to represent the area reflects the levels involved so that there are clear points of demarcation where a student can attain certified competence up to the level commensurate with his individual abilities. This concept of multiple exits at various training levels will provide specific usable skills for each student regardless of the time he chooses to terminate his full-time school activity.

RATIONALE

The methodology for the selection of training programs for development by Project ABLE has been defined in the First Quarterly Technical Report, AIR, 1965. The criteria and considerations outlined in the report and applied to the development of Power Mechanics curricula focused on jobs which:

1. In comparison with related jobs, require performances of a wider variety of tasks and a larger range of skill levels.
2. Require an appropriate amount of vocational training time (given various limitations of a vocational-technical school program).
3. Have entrance, apprenticeship, or on-the-job training requirements which can be met better as a result of vocational training. Thus, jobs for which the training graduate could substantially meet the entrance requirements, or would be allowed to progress more rapidly through apprenticeship and additional training programs, could be favored for selection. Jobs which could be entered only after long service in another job, or only after an extended, fixed period of apprenticeship, or additional training, or only by meeting requirements beyond the control of the training agency would be less desirable candidates for selection. This principle is _not_ intended to imply that the content of vocational training should include only that which pays off immediately in a job. It _is_ intended to foster meaningful and lasting vocational rewards for the student who performs successfully in training.
4. Are appropriate with respect to the cost, size, support requirements, and expected usage of training facilities and training equipment.

5. Are predictable with respect to the skills and knowledges which will be required in the next five years. Of course, radical changes may take place unexpectedly in any vocational area. In such a case, training plans can be prepared or modified when the performances, skills and knowledges can be identified, but not before.
6. Have favorable employment expectations in the time period for which training is being prepared.

Such steps are an important part of the broader feasibility study.

One of the major goals of the Project is that of applying newly developed educational technology to the design, conduct and evaluation of vocational education. Techniques of identifying objectives and stating the behaviors desired of a student when he has completed the particular course of instruction are basic to the "newly developed educational technology". The behaviors for vocational areas are derived from an analysis of tasks or job activity in the occupational family in which training is to be offered. The "newly developed educational technology" then includes the processes of job and task analysis. Careful attention to such procedures should provide the basis for the identification of learnable skills and knowledges.

DEVELOPMENT

Identification and Selection of Jobs

Job selection in the Power Mechanics family involved careful consideration of several hundred jobs which might possibly have been related in terms of skills, knowledge, and training. Several principal sources of data were used to identify the population of jobs. These were:

- Dictionary of Occupational Titles (D.O.T.)
- Occupational Outlook Handbook and sources referenced therein.
- The knowledge of the vocational area experts.

Additional sources included the Position Classification Standards of the U. S. Civil Service Commission, the Wage Board Standards for civilian employees of the Air Force, Navy, and Army. Also, the U. S. Employment Service and the State Employment Service were consulted and involved in a local survey of the metropolitan area. As a result, nearly 140 occupations (Appendix B) were identified as potential training areas for a vocational school.

The occupations were then grouped and arranged on a hierarchy of skills, knowledges, and training time. Other factors considered were job activities involving people, data, and things as defined in the D.O.T. An analysis of the job tasks horizontally and vertically within the hierarchy was then attempted. "Clusters" or "sub-families" based on job similarities were identified at each level on the hierarchy. Jobs only remotely related to the emerging clusters were eliminated.

The next step involved the selection of a smaller set of jobs which were representative of not only the emerging clusters or sub-families, but of the job family as a whole. Care was taken to select jobs which would differ from one another in the performance required and, taken as a group, would include substantially all of the learnable skills and knowledges which are both appropriate for the training programs and demanded by the job family.

The current job chart (Appendix C) illustrates a sequence of training vehicles or representative jobs which may be considered milestones or exit levels within the hierarchy. The Selected List (also Appendix C), presents examples of similar occupations which together form a sub-family, or in other terms, jobs with similar or less stringent skill, knowledge, and training requirements. The materials in Appendix C will be valuable as guidance information and should be made available to students using the curriculum units. It is essential that both teacher and student maintain an awareness of the breadth intended for the program. Laboratory activity should be oriented whenever possible toward the family cluster. Field trips, films, brochures, and other materials are resources which should be utilized for such purposes.

An important aspect of the development is the relationship of the job hierarchy to the specific kinds of learning required for each job at each particular level within the hierarchy. Dr. Gagné, in The Conditions of Learning, identified eight major classes of capabilities which he linked to corresponding kinds of learning. He described eight types of learning, each of which begins with a different state of the organism and ends with a different capability for performance. The prerequisite for a type of learning is what distinguishes one type of learning from another. The internal conditions for chaining, for example, require that the individual has previously learned stimulus response connections available to him, so that they can be chained. The generalizations applied to the varieties of learning may be briefly stated as follows (types indicate kinds of learning):

Problem solving (type 8), required as prerequisites,
Principles (type 7), required as prerequisites,
Concepts (type 6), required as prerequisites,
Multiple discriminations (type 5), required as prerequisites,
Verbal associations (type 4), or other chains (type 3),
  required as prerequisites,
Stimulus - response connections (type 2) (Gagné, p. 60).

Action verbs which describe the major tasks of lower level jobs such as identify, indicate, hold, locate, pick-up, repeat, etc., also correlate with the action verbs related to specific kinds of learning indicative of type 1 and 2 learning as described by Gagné. On the other hand, action verbs which describe the major behaviors of high level jobs (analyze, contrive, develop, diagnose, trouble-shoot, etc.) are more likely to correlate with the action verbs related to the type 7 or 8 kinds of learning. If the type 2 learning is prerequisite to type 3 and 3 to 4, etc., then most of the skills and knowledges basic to the lower level jobs are prerequisite to effective and functional performance at the higher and more sophisticated job levels.

Students should be made aware of the fact that jobs such as those listed in the first level (Appendix C) encompass skills basic to tasks required for the second level. Many of the first level activities are repeated at the second level but with more stringent standards and broader areas of responsibility. Problem solving activities at the higher job levels will require a solid foundation of prerequisite skills and knowledges--commonly called "learning the basics".

Job Description

A general job description has been prepared for each of the representative occupations.

The purpose of the job description is to provide information which is useful in defining the behaviors required of an incumbent. Of course, the analysis of the behaviors typical of a particular job provides the basis for the identification of learnable skills and knowledges. A complete job description and task enumeration for the first level of training in those occupations related to automotive mechanics, are included in Appendix E. A job description and task enumeration for the second level of training is included in Appendix F.

The First Quarterly Technical Report defined the procedures and major sections for the job description. For example, the initial section (for Service Station Attendant), Definition of the Population, attempts to distinguish the jobs to be included from the excluded jobs of a similar title. A brief general description is given of formal characteristics of job incumbents along with information about the industry. This helps to delineate the tasks. The Statement of Mission identifies the different purposes and modes of operation which influence performance of the job. It can define alternative objectives, operational modes and hierarchies of goals. It sets the criteria by which one can judge performance and sets the objective toward which all tasks are aimed. The Segments identify sub-operations of the mission and serve as important organizational aids for the tasks. They indicate sequences, time phases and categories of operations. They are the major steps in the regular sequence of job performance. The section Functions lists general activities performed on the job focusing on the categories of things, data, and people. The section Contingencies identifies conditions under which the job is to be performed--the usual and the unusual.

Task Classification provides a list of specific statements of action. A task is the smallest convenient unit of job activity having a separate purpose. Tasks are suggested throughout the process of preparing general job descriptions. The tasks are classified into Basic, Specialty, Advanced, Auxiliary, and Redundent categories. Only the basic tasks are analyzed in detail. Organizing the occupation in this way is critical to the process of identifying the essential and learnable skills and knowledges. Furthermore, since the training is pegged to entry level employment, the system described is of value in maintaining the proper perspective.

The Task Analysis (also Appendix E) for the first level, provides the training specifications or educational objectives stated in behavioral terms. (The task analysis for the second level program, at the writing of this report, had been temporarily curtailed due to a shortage of developmental funds.) The specifications in this study were listed in the form of course and topic objectives. Course and topic objectives, derived from the task analysis, represent specific statements of behaviors which identify what the student is expected to do, the conditions under which he is expected to work, and the standard of performance. (Project ABLE first, second, and third Quarterly Technical Reports, and Mager's book, Preparing Instructional Objectives, are recommended reading.) The statements of behaviors are intended to be used as a "roadmap" for the curriculum developer. Translating such objectives into practical, efficient and functional "performance evaluation units" and "learning units" is another phase of development with quite a different set of problems and activities.

Researching the general job description required the use of the same references and resources used for the Identification and Selection of Jobs. In addition, a task enumeration computer print-out secured from the Training Center at Lackland Air Force Base, was most valuable. An analysis had been made of automotive and vehicle service activity at all major repair and service sites. It was possible to identify and remove those activities related only to military equipment and components. It should be noted here that most of the ground passenger vehicles used by the Air Force are standard production units. The analysis identified the frequency with which each task was performed, the percentage of time spent on each type task, the percentage of time spent on each task by grade or job level, time requirements, and other information.

One of the more difficult and time-consuming activities was that of task analysis. Again, this resulted in specific statements of behaviors which identify what the student is expected to do, the conditions under which he is expected to work, and the standard of performance. Important here is the fact that the automotive repair and service industry has been, during the past few years, under Congressional investigation. The industry has been accused of malpractice in service functions to a degree which has been considered dangerous to the safety of the public. (The Senate Anti-trust and Monopoly Subcommittee, according to a report attributed to Chairman Sen. Philip A. Hart [D.-Mich.], is planning a third round of testmmony in September or October of 1969.) With this in mind, the identification of standards became a very important consideration. A decision was made to use as primary resources for the task analysis, vehicle warrantee standards and technical and service manuals. A review of the behavioral statements derived by such methods was made by content experts and members of the advisory committee.

The task analysis was performed in two major stages. (1) The initial document and the "roadmap" (behavioral statements) for curriculum development were prepared (Appendix E). (2) The revisions and clarifications which included a more detailed breakout of performance items, were finalized in the form of checklists. The checklists became the "backbone" of the performance evaluations (See Appendix G and Appendix O) and are considered essential to the establishment of proper training standards and procedures.

Criterion Test

The behavioral statements provide standards upon which judgments and decisions can be made. Criterion tests, in the form of performance evaluations, developed for the Power Mechanics curriculum are intended to serve that function--judgments and decisions on the behaviors of trainees measured against a predetermined set of absolute criteria. The form of the criterion test or performance evaluation was suggested by the emphasis on what can be described in simple terms as "hands-on" learning activity.

Placing emphasis on the "hands-on" approach was reached in a very early decision. The attitudes of students (typical of those electing Power Mechanics) toward academic and classroom-type school functions, the nature of their vocational goals and and choices, the rationale for the program, and the objectives of the Project, clearly established such an orientation. Furthermore, the identification and selection of jobs, the job description, and the task analysis, produced behavioral statements which require the student to "do" something to prove or demonstrate his ability to perform the tasks required for employeemnt in the job family he has selected for training.

The instrument evolved to assess the student's ability to perform is built upon the delineation of behaviors in the form of an instructor checklist which is part of the performance evaluation (See Appendix O). This has proven to be a practical and functional means of structuring the observations necessary to make the required judgments and decisions. Again, such judgments and decisions must be carefully based on the established standards and criteria--this is a critical aspect of the methodology and program.

The instructor checklists are intended to serve a number of functions. The checklists

1. provide an instrument for evaluating and recording data on student performance.
2. provide a set of standards for the student. From these the student can determine what it is he is expected to do and the criteria against which he will be evaluated.
3. provide for the student, a quick means of reviewing (at a later date) the content and job standards.
4. provide the student with documented evidence of his capabilities and experience. This could be of value in job seeking.
5. provide guides for structuring and organizing learning activities. Furthermore, the checks can pinpoint areas where practices or additional instruction is required.
6. serve as guidance and data collection instruments for the purpose of analyzing individual or group progress and problems.
7. provide an instrument for assessing retention both during the course and after graduation.
8. will be of value in pinpointing revisions required in not only the learning materials but the objectives and job standards.
9. serve as the basic research instruments for validation. Such instruments should prove valuable in comparing graduates to the general trade employees, comparing graduates to students from traditional or conventional programs, verifying standards, etc.

Performance evaluations (See Appendix G) include references and prerequisite activities, a written test with appropriate items, a brief shop activity outline with instructor checkpoints, and the all-important checklist or breakout of behaviors. (The Occupational Readiness Record [Appendix J] provides a summary and certification of student performance and progress.)

The performance evaluations are intended, of course, to measure the student's ability to perform to the job standards. This implies being able to do the job without the crutch of learning units or similar instructional materials (excluding standard manuals which must be used). Therefore, a time interval should be maintained between the use of the learning units (or alternate activities) and the administration of the performance exam. However, specifying such intervals would be difficult because of the many variables which must be taken into account. The instructor must make such decisions often, assessing a number of factors including student characteristics, the particular task to be performed, time remaining in the course, etc.

It should be noted that retention on specific performance items will also be evaluated as a part of the second level program (assuming most students will remain in the program). All activities will be repeated as a part of more complex tasks or at more stringent job standards. The second level program begins as soon as the basic course is completed and for some students this is only a matter of a few months.

In some ways, the performance evaluations are similar to end-of-course exams where both written tests and practical applications are required. However, it would be more appropriate to consider the ABLE materials as pre and/or post test type instruments. End-of-course exams have not been developed for ABLE Power Mechanics and would be considered unnecessarily redundant in a program where evaluation is a part of every day's activity. Furthermore, the type of skill and knowledge which can be measured by the typical end-of-course exams and the time limitations involved, make other alternatives more practical and functional. By design, much time is allocated to testing and evaluation in the ABLE course. This must be considered a dynamic feature of the new instructional system.

A carefully designed set of performance evaluation instruments should enable the instructor to utilize a variety of activities, methods and materials to assist students in the accomplishment of the objectives. However, the availability of a well written set of supporting curriculum materials will, in reality, provide a practical and manageable program in which a large number of diverse activities can take place. Given a basic structure the instructor can then provide for alternative learning experiences more appropriate to individual learning styles and capabilities.

Target Population

The immediate goal of the developmental effort was to service tenth grade vocational school students electing the course of study in Power Mechanics. It is assumed that the trainees have made a reasonably stable and appropriate career choice as a result of involvement in the Project ABLE junior high school guidance program. (See Quarterly Technical Reports four and nine.) The curriculum design calls for a program built on the hierarchy of skills and knowledges with spin-off or exit points which would make a student employable whenever he left or at whatever level he was able to achieve. It is expected, however, that most students will progress at least into or through the second level of training.

Since the standards and course objectives were derived from an analysis of specific occupations or job families, the criteria established has no school grade level restrictions. While the content in the learning units was prepared to service the needs of tenth grade students and while revisions were largely influenced by the problems of the test group, minor modifications should make the course suitable for other populations requiring similar instruction in the particular job area.

The reading level required to work with the Power Mechanics materials will place some restrictions on the selection of trainees. For example, urban ghetto trainees with reading levels below grade

6 or 7 would probably have considerable difficulty in such a program. Furthermore, such persons would not be able to use adequately, the necessary technical manuals, service guides, and lube charts--all of which are critical to effective job performance and advancement within the job family. If it be the intent to train such individuals for jobs beyond the lower level (using materials such as those described in this report) then remedial reading instruction should be a part of or precede the first level job training program.

A well designed multi-media supporting package would broaden the potential user population. On the other hand, the cost of such materials and equipment might tend to discourage implementation.

Publishers usually attempt to service a rather broad market. Should such a company elect to disseminate the program, the definition of target population would change. For example, various units and sequences would likely find use in industrial arts programs. Commercial quality in terms of printing, illustrations, and other media, would also have positive effects on the efficiency and effectiveness of the program.

It should be noted that several basic assumptions were made of the intended target population. (1) It was expected that a majority of the trainees would be willing and able to read the service manuals and lubrication guides required for the trade; (2) It was felt that evaluation and instructional materials could be prepared to reflect the reading requirements and terminology common to that level of employment and therefore appropriate for the target population; (3) It was also assumed that most trainees would not leave the program at the first exit level, but would continue with many completing the second and some the third level programs; (4) It was assumed that most students would prefer the "hands-on" individualized self-paced program over the more traditional type class activities (typically group lectures and demonstration lessons with classroom reading assignments).

Learning Units, Sequence and Strategy

The development of learning units was undertaken immediately following the drafting of the performance evaluations. While this may be contrary to recommended procedure, the intended use of the materials and practical considerations warranted such development prior to the testing of performance evaluations. It should be noted that the Project ABLE learning units are one of several alternative methods and resources available to the student and teacher. The units were prepared in the briefest form possible, presenting only that information essential to achieve the unit objective. The content was written in a step-by-step form. The units require the extensive use of other references--particularly technical manuals and service guides.

The major sources of content for learning units were the technical manuals (not to be confused with text books) and service guides which provided the basic information for the establishment of job standards. The process of identifying appropriate content also served as a review of job standards.

One major strategy and objective was to structure an environment that would, in fact, support a program of individualized instruction. It was therefore necessary to identify alternate means of presenting content information other than traditional group demonstrations and lectures. Some provisions were necessary, where appropriate, to allow for self-pacing and independent study. It should be noted that previous attempts by the Project had failed to produce operational programs. The lack of alternate means of instruction such as detailed laboratory guides with "how-to-do-it" information, were among the problems cited. Furthermore, "stop" or "check" points to enforce safety and to provide for instructor evaluations were not identified. Inadequate training aids, excessive paper work, too much reading, tool and equipment problems, were also among the factors affecting implementation.

A number of constraints affected curriculum development. For example, neither Project nor school funds were available for the development of a multi-media instructional system. Therefore, the primary media was of necessity in the printed form. It should be noted, however, that numerous drawings, slides, films, a teaching machine, training aids, and mock-ups were extensively utilized.

Another constraint was evident in the short time available to produce a demonstration program. Expedient short-cuts were necessary. Staff time available for curriculum development created another problem. Neither Quincy nor AIR personnel were available for full time service for Power Mechanics development. The extent of the effort and the time required for curriculum development were not evident during the early stages of Project planning and implementation. Suitable and appropriate commercial materials for individualized instruction and "hands-on" lab activity keyed to behavioral objectives, were not generally available. The problems of curriculum development and implementation in general, are reviewed in the Eighth Quarterly Technical Report.

The design of the learning materials and instructional system was intended to reflect current thinking on individualized instruction. However, the program is limited to certain aspects or interpretations. Of the many interpretations to be found of the term, the following six meanings are probably the most common and frequently discussed. They include: (1) allowing students to decide on their own objectives; (2) giving students the option of selecting their own methods and media of instruction according to their own particular likes and dislikes; (3) building a learning system that is automatically responsive to the needs and abilities of each student (e.g. CAI); (4) letting the students as a group decide on the goals and the methods of instruction; (5) individual evaluation of student progress; (6) allowing individuals to progress at their own rate (perhaps the most common meaning at this time); and, of course, (7) various combinations of the above.

The Power Mechanics program incorporates a combination of the meanings in both the design of materials and the method of application. Specifically, item by item: (1) The ABLE guidance program assists the student in establishing or clarifying his objectives and career goals. After electing a program the student will find the objectives are determined by a thorough job and task analysis process. However, the well-structured program should provide for exceptions and flexibility on an individual basis through instructor and student "options". (2) The performance evaluation defines clearly what it is the student must be able to do, and provides instruments and means for assessing his performance. The highly structured learning units are but one of several alternatives and options available to the student and teacher. It should be noted, however, that the learning units were prepared because of past difficulties in organizing a program of instruction and difficulties in identifying suitable learning materials. (3) The materials are compatible by design, to computer systems such as that being tested by AIR and Westinghouse Learning Corporation through Project PLAN. An automatic responsive system utilizing the Power Mechanics units as a part of a broader program is being considered. (4) The job and task analysis from which behavioral objectives are derived systematically, establish goals and to a degree, methods of instruction. Vocational training requires considerably more structure than other school activities which might be more appropriate for group decisions on goals and methods of instruction. (5) Individual evaluation, and (6) self-pacing (given the objectives and standards identified through the job analysis) are the key features of the ABLE Power Mechanics program.

Reinforcement of learning and effective feedback techniques were major concerns during the development. Since alternate and optional activities were identified in addition to the learning units, structuring reinforcement and feedback presented some problems. Therefore, special emphasis was given to the performance evaluations and to the checklists which are included in both learning units and performance evaluations. (See samples of performance evaluations, learning units and instructor checklists in Appendixes G, H, and O.) In a previous section on the "Criterion

Test", the functions of the checklists are defined. To reiterate, the checklist provides a means of structuring practice on those activities which have caused some difficulty for a student. The instruments also provide a means of assessing retention both during the course and after graduation.

Nearly all of the training aids and test questions were keyed to the self-scoring response cards (See Appendix P). Within the body of the learning units, numerous questions were also keyed to the response cards. Furthermore, instructor checks throughout both the learning units and performance evaluations, provide additional opportunities for reinforcement and feedback. The emphasis on "doing" and "hands on" activity, along with explanations and theory, presented in small steps, is in itself a highly affective reinforcement and feedback technique. For those students using the learning units, repeating the tasks on the performance evaluation will provide a second opportunity in which to practice and check performance.

Hopefully, the units as prepared will provide content information when the student needs it, and at a time when such information is most meaningful. Realistic practice with the step-by-step intermingling of demonstration and instruction (with a minimum of delay) was a goal. The strategy demanded maximum participation by students including confirmation and repetition where needed. Straight information was interspaced with questions keyed to the self-scoring cards. The Socratic method was incorporated frequently, especially in those areas where answers were fairly evident and easy. The program is also designed to give teachers more time for the important tutorial functions on an individual basis. In such activities, the instructor as a manager of learning, assumes an important role.

Early attempts by the project to implement new programs relied heavily on classroom reading assignments as the major vehicle of content presentation. (Extensive use of multi-media materials on a large scale was prohibitively expensive. Lectures as a primary instructional method were not compatible with the goals of individualized instruction.) With the aid of "guide sheets" students were usually required to study certain texts and manuals before proceding on shop activities. Student achievement, using such materials and methods, was found to be unsatisfactory and progress was unacceptably slow. Discipline became a problem.

It was felt that reading attitudes were as much a hindrance to learning and acceptable progress as reading ability. The Power Mechanics program was, therefore, designed to reduce textbook type instruction and reading assignments. Emphasis was given to "hands-on" type instruction, with most of the activity taking place in the shop. Experience with the initial test groups has found few students objecting to the type of reading included in the Power Mechanics learning units and performance evaluations. Pupils were no longer required to endure lectures and classroom reading assignments and that, they felt, was quite an improvement. While considerable reading is involved in the new learning materials, it is broken into short segments interspaced with shop activity. Most students, when questioned about the amount of reading involved, did not seem to sense that quite a large number of words were, in fact, included. If given a choice, however, most would have preferred to do the lab work without learning units and performance evaluations. But then, many would not have been in school if given that choice on the day such discussions took place.

The learning materials and references required for the first level Power Mechanics program should be of value in improving the reading skills and vocabulary of many such persons interested in the particular occupational area. The "hands-on" activities with reading broken into short sequences, should serve to reinforce the terminology and words common to that occupational area.

The problems of motivating students, especially those in the vocational school, strongly influenced the overall design in other ways. The learning units, for example, include information which describe for the student exactly what he is expected to do. It also describes the function or use of the new knowledge or skill. The goals are presented in a way which make them attainable and attempts are made to convince the student that the goals are desirable and necessary. Realism and practicality were major objectives. The methodology insures reinforcement and anticipated early use of skills and knowledges learned as a result of the course experiences. (The first level job tasks will likely be required of most persons entering any number of the phases of the job family.) Knowledge of progress is also very important to student attitudes, cooperation and progress. To this end, the feedback devices, statements of objectives and means of evaluating the objectives, the Occupational Readiness Record, the activities checklist, and other features place heavy emphasis on the assessment and reporting of student progress. And, more important, in all such aspects of the program design, active student participation is unavoidable. He is responsible for his own learning and is required to do things for himself.

INITIAL TESTING AND VALIDATION

The performance evaluations, as were the learning units, were developed during the summer of 1968. They have subsequently undergone two thorough revisions on the basis of tests conducted during the first and second semesters of the 1968-69 school year. (See flow chart in Appendix A.) Development in the Power Mechanics area was restricted primarily to the first exit level. Since the Project, in general, was experiencing difficulty in establishing operational programs on a rather large scale, a pilot model seemed appropriate. It was therefore decided that the first level basic program would be revised and modified until all major problems were solved. An efficient, functional and well-organized operational program as a model became the prime requisite to any further development not only in Power Mechanics, but in other vocational areas as well. At the time of the preparation of this report, it was agreed that the basic objectives had been achieved and development of the second level program was initiated for Power Mechanics.

The test population were tenth grade vocational school students who had elected the Power Mechanics family for occupational training. The tenth grade class was composed of two groups (17 to 19 students per group) assigned to the area for three periods of shop each day. One group was scheduled to the auto body area, the other to the auto mechanics area. The groups were switched at mid-year, enabling all students to gain experience in both areas. For those students who had definite career choices and strong preferences for one area over the other, special provisions were made. For example, at least seven students who identified closely with the auto body area (and were strongly opposed to spending a complete semester in the auto mechanics area) were assigned only those tasks which were common to both sub-families. Upon completion of the common tasks, such students returned to their area of preference.

Approximately 25% of the students had gained some experience through summer or after school jobs as service station attendants or similar occupations. On the other hand, the instructors estimated that approximately 25 to 30% of the class members had little or no experience in the job area. Such students demonstrated difficulty with the basic tools and nomenclature and displayed no more knowledge about vehicles than one would expect from the general school population of vocational students. (Power Mechanics is not offered as a part of the Quincy junior high program.) The remainder of those questioned claimed varied experience such as work on small engines, watching and helping relatives or friends on tune-ups and mechanical work, helping around garages and service stations, etc.

Two instructors and one AIR scientist were assigned to the test program. The initial plan called for an approach drawing on case study methodology with the primary focus on the two groups, "experienced" and "non-experienced". Each unit was tested with several students in each of the two groups. The same materials were also used with the remainder of the class. In addition to testing performance evaluations, learning units which had been prepared during the summer, were implemented and tested.

The initial attempt at testing and implementation was fraught with many problems. For example, the early units followed very closely the topic objectives. This resulted in many fragmented activities which were difficult to organize and control. The evaluations were time consuming to monitor and the paper work overburdening. Student motivations became a serious problem with what, in too many instances, appeared to be unreal and meaningless skill training in segmented and unrelated activities. Revisions for the second semester combined topic objectives in the form of projects or activities which could be done on live vehicles as well as training aids and mock-ups. Such jobs became more functional. Short activities were combined to make longer units which resulted in fewer "stops and starts". A more manageable organization for the instructor was established.

The students in the "non-experienced" group (naive population) were unable to perform the tasks required by most of the performance evaluations. In many instances the tools and equipment were damaged and safety became an important consideration. The test indicated very quickly that training was required and that most items included in the instruments were necessary and not redundant. While many deficiencies were pinpointed, most were problems of clarification--especially in the behaviors required to meet the objectives. Students in the group identified as having had "some experience" in the job area, also demonstrated considerable difficulty with most evaluations. The instructor time required to supervise performance evaluations without some prerequisite instruction was simply not practical with the majority of the inexperienced students.

The third or "experienced" group demonstrated limited success on most tasks and topic objectives. Their major problem areas were; work and safety procedures, identification of critical specifications, proper use of tools and equipment, and the use of manuals prepared for service station attendants and mechanics. (This tended to confirm some of the serious criticisms of the industry.) An example would be the fact that no student checked tire inflation specifications before making adjustments on various vehicles. Such seemingly minor procedures are actually quite critical considering the safety factors of high speed driving under differing load weights and conditions. Operations requiring the use of torque wrenches were universally ignored as were many other practices which are cause for alarm. It was also evident that most students, including those from the "experienced" group, had learned many "bad" and unsafe practices from supervisors, fellow employees, and friends who either lacked proper training or failed to use proper procedures. The methods used in establishing standards were reaffirmed.

The initial test was terminated after the third month of operation. All student materials were collected including instructor checklists. Much of the information for revisions came from master correction copies maintained by each of the three researchers. While the number of students attempting each unit varied from only 4 to 13, the frequency data, when supplemented with the detailed comments from students and observers, yielded much valuable information. It was found that the technique of intensive observation (and comparison of students from each of the three groups) was an effective and appropriate method for the initial developmental stages. A careful examination of student responses on each unit and interviews after each unit was completed, were also quite useful. A form used to assess student reaction and opinions (See Appendix I) was of limited value (students objected to and resisted the paper work) and was not used during the second test. It should be noted that frequency data and statistical information from such assessment forms have not been, for the most part, documented in detail in this report. Because of the small size of the test population, reporting such data would be meaningless without also listing extensively recorded anecdotal responses from the efforts of intensive monitoring.

One of the tasks of the research scientist was that of observing group interactions. This proved most valuable in identifying problem areas such as those dealing with laboratory and course organization. For example, one of the major hurdles faced in the implementation of the individualized and self-paced program was that of providing an effective way of administering the performance evaluations. Methods had to be identified for shifting of the responsibility for the grading of test items to the students. Effective instruments had to be developed which would reduce paper work for the instructor while still enabling frequent and effective monitoring and evaluation of each student's progress. As a result, student self-scoring, self-response cards along with improved instructor checklists were developed. These proved quite effective during the second test. (Both are explained in greater detail in the section of Course Organization and Management.) The self-response cards also provided a practical means of performing an item analysis on each of the questions included in the evaluations (See Appendix P).

The second phase of development centered about two major activities: (1) The objectives, performance evaluations, and learning materials were completely revised and rewritten. Modification of objectives primarily dealt with problems of clarification. (2) The shop was completely reorganized with a new system of tool control, development of needed training aids and mock-ups, assembly of parts and materials required by the evaluators (e.g. samples for those objectives which required students to differentiate between various good and defective components) and other critical environmental management problems.

The second test was postponed for nearly four weeks after the start of the second semester. The reason for the delay was a decision not to initiate a controlled experiment until all training aids, tools, equipment, audio-visual teaching aids, and other items were in place and operational. Procedures followed during the second test paralleled those established for the first attempt. The improvements incorporated during revision and reorganization resulted in a greatly improved learning environment. Student attitudes and work habits improved. Discipline problems declined as a highly efficient instructional program emerged. Again, the three staff members tested each unit with students from each of the three groups. The new materials and performance tests enabled a more detailed analysis of student behaviors and achievement. Most of the information collected seemed to indicate that the only major revisions and modifications required were in areas related to course organization and management.

Technical problems and errors were readily identified and performance items which were causing problems or difficulty were easily pinpointed. The instructors were more efficient in identifying students who were reasonably safe on performance evaluations without prerequisite learning activities and instruction. Such factors, coupled with the improved highly structured learning units, resulted in few recorded failures on items included within the instructor checklists. Because of the need for test subjects, most students were not allowed to use prerequisite resource learning materials other than the Project ABLE learning units. While this is not the way one would operate a flexible program of individualized instruction, it did result in a low rate of failure on specific checklist performance items.

An important part of the revisions incorporated as a part of the second phase testing, were the modifications adapted as a result of an analysis of the grade reading level. The "Fog Index" fornula was applied to each unit. This process incorporates the following steps:

1. Pick out representative section of 100 words.
2. Count number of words in section sentences. (Skip proper nouns.)
3. Add numbers and divide by number of sentences.
4. Count number of words of 3 syllables or more. (Gives percentage.)
5. Total 3 and 4 and multiply by .4.
6. Answer is Fog Index or Reading Level.

Dunning, Robert, Technique of Clear Writing.
New York: McGraw-Hill, Rev. Ed. 1968

The analysis found considerable variation of reading levels within units and among units. Typically, the first page which included several paragraphs of information including the overview, tended to rank at a higher grade level than the steps included within the body of the units. The technical terminology required by certain units caused some variation among units. The present set of materials range between grade six and grade nine in reading level.

During the second phase testing period, the U.S.O.E. sponsored a review and evaluation of Project activity. A panel of eminent educators visited the site and examined the materials. Their report briefly commented on the progress in the Power Mechanics area:

> Instructional materials are very well written, strong on theory, testing, and records. Shop organization is excellent and tool kits are provided for each job to be done. Students use teaching machines and mock-ups in learning the subject content.

> Some of the jobs require too much reading prior to doing a simple task. Evaluation of student retention appears to be weak, and some of the operations or jobs would be better taught in a work-experience program.

These and other suggestions from the evaluation report have received careful consideration during the revisions and modifications following the second test phase. It should be noted that some of the criticisms can be corrected by altering the method of implementation. Because of the small population of test subjects, many of the Power Mechanics students were involved in tryout activities which would not have been appropriate to a fully operational program of individualized instruction. A proposed field test, (see section on recommendations) and the next stage or phase for Quincy, will enable a greater degree of flexibility in the overall instructional approach. Considerable thought has been given to such factors.

Planned as a part of the second test phase, was a comparison of the tenth grade students to the eleventh grade students on performance items. Toward the end of the school year, an initial attempt was made but terminated because of time factors. The eleventh grade students required a degree of instructor assistance and supervision which would have consumed more staff time than was available. Those few eleventh graders tested had considerable difficulty locating required specifications and information from the manuals and catalogs. They were unable to progress through units or to pass instructor checkpoints without retracing steps to correct errors in procedure and safety.

An alternative method of comparing the two groups was employed. A paper and pencil test, incorporating questions from the performance examinations was assembled. Items were chosen which appeared appropriate and representative of the behaviors specified.

The test was administered in June near the end of the school year. A total of 120 questions was included. The results were as follows:

Juniors	Sophomores
$N_1 = 8$	$N_2 = 16$
$M_1 = 75$	$M_2 = 86$
$R_1 = 58$ to 86	$R_2 = 67$ to 106

N = number
M = mean
R = range
df= degrees of freedom
P = probability level
t = value in distribution table by Fisher

A difference between means test yielded the following information:

$$t = \frac{M_1 - M_2}{\sqrt{\frac{\Sigma x^2 + \Sigma y^2}{N_1 + N_2 - 2} \quad \frac{N_1 + N_2}{N_1 N_2}}}$$

$t = 5.29$
$df = 22$
$P < .001$

The probability is quite remote that the differences between the means are due to chance.

It should be noted that the activities and test items of the first level ABLE program must be considered as very basic to any course, traditional or otherwise, in auto mechanics and related areas. The eleventh grade students would have been expected to have had considerable experience and practice in that area.

The techniques reported herein are considered practical and functional for the initial stages of pilot development. However, a more adequate program of validation and testing is recommended. A larger test population in varied geographic areas would seem to be the next logical step. While the results from such a small population may not be generalizable to any great extent (and subject to question in terms of reliability and validity), it is the opinion of the staff that the course is functioning as intended.

COURSE ORGANIZATION AND MANAGEMENT

Instructor's Role

It is evident that certain behavioral changes will be required by students participating in a program such as described in this report. They are given a great deal of responsibility for their own learning. The students are required to meet standards and to demonstrate capabilities in ways not common to traditional type programs. Their relationship with the teacher has changed as well as the way in which they receive instruction. Certain behavioral changes are also required of the teacher. He is no longer the lecturer and major source of content and procedures. He works primarily with individuals on a face-to-face basis in situations where a wide variety of activities are likely taking place. The new role is often described as that of a "manager of learning". He is, in effect, a course administrator and an individual tutor and counselor.

The systems approach requires a very carefully managed program. The development is precisely engineered throughout all phases. As a result, rather specific tasks and duties are required of the manager-teacher. The Power Mechanics program has, in keeping with the design, been very carefully structured and organized (also a necessity as a result of problems experienced during the initial test). An examination of the sample learning unit and performance evaluation (Appendix G and H) will illustrate the type of activity required of the instructor. It is doubtful that the program could function as written, without the careful attention of the instructor to the details of the management system.

While effective management is essential, the instructor's role as an individual tutor and counselor is the more important. The course as prepared, cannot take care of all individual needs and differences. Flexibility has been provided and alternatives must be exercised whenever possible. The instructor must be aware of trouble spots and ready to provide assistance where necessary. Some students will progress very fast, others will go too slow. The extremes must be serviced and the minor differences left to the ingenuity of the teacher.

Lecturing and mass demonstrations, as the major vehicles of instruction, are not appropriate with the new system. On the other hand, large group and small group sessions have a valuable function if used properly. Special demonstrations by community resource persons and vendors are always useful. Sessions for occupational and employment information and the viewing of some excellent films available on the industry, are certainly appropriate group activity. Discussions on topics or problems such as those affecting the industry should be a part of every program. The reader should understand that the materials described in this report are not intended to be the sole source of student educational experiences. Enrichment activities, citizenship instruction, attitude development, occupational information, career counseling, etc. will require the services of a professional educator interested in the welfare of his students--as individuals.

It is assumed that schools (e.g. ES'70 member systems) implementing and testing programs such as the Power Mechanics course will have offered instruction and information on individualized instruction, systems development and educational objectives. It is also assumed that such schools will have inservice training programs available to assist instructional staff in the implementation and operation of programs such as that described in this report.

Shop Organization and Equipment

The initial investment required to support a program with objectives such as those stated for the Project ABLE Power Mechanics course has been carefully analyzed. The cost analysis is summarized as follows:

Training Engines and Mock-Ups	$ 371.
Tote-Trays (supplies, small tools, parts, etc.) .	214.
Equipment benches, vises, jacks, misc. tools, etc.	1,086.
TOTAL	$1,671.

Numerous items required for the first level course are also earmarked for use in the second and third level courses. Costs, where appropriate, have been prorated accordingly. Costs exclude permanent building fixtures, student desks for the classroom, bookcases, security enclosures, and similar items which would vary from one school to another. Excluded also are some donated equipment and used parts. Automobile agencies and manufacturers typically contribute engines and various components to most schools. It is expected that institutions wishing to test the Project ABLE Power Mechanics program would have the benefit of such services. It should be noted that many of the training aids are worn or defective components typical of those serviced by the industry. Such items are usually quite inexpensive.

It is the opinion of the instructional and research staff that the costs of the ABLE program are quite low when compared to suggested equipment lists for the more traditional curriculums. The careful identification of objectives and specifications should be expected to result in a more efficient management and economical operation of vocational school programs. The systems approach is intended to serve such functions. Systems techniques should also improve the capability to project costs and to project equipment and supply needs. Credibility of staff tool, equipment and supply requests can be more objectively evaluated. The ability to better identify and establish priorities and deadlines should be another advantage accrued from the systems approach.

It should be noted that cost savings were not an objective of the development considering that the investment and support in vocational training has, in the opinion of many, been unreasonably low. It should be noted that a multi-media system has not yet been applied to the program. The lack of funds has hindered in some ways, needed educational acquisitions and services.

A list of mock-ups, training aids and equipment is included in Appendix M. An attempt to implement a test program without having such items fully operational and properly marked, will result in serious problems. Most units require responses by students to items labeled and keyed to self-scoring response cards. Furthermore, evaluation cannot take place unless certain aids and samples are available and, again, properly identified. For example, students are required to identify common defects and deposits on spark plugs. The examples in this case, must be properly organized to enable an assessment of student capability on a major course objective. Similar items are included with nearly every project or activity.

Appendix N provides a list of Tote-Trays which includes the small tools and supplies required for each unit or activity. Again, such items are essential to the program as designed. The system described was evolved after early attempts to utilize a central tool room proved unmanageable. Pilferage, time required to locate tools and supplies, lost or misplaced essential items which hindered progress, and similar problems proved unacceptably disruptive to the instructional program. Such difficulties were effectively solved by simply establishing complete training stations. The cost was minor in view of the efficiency and effectiveness gained.

The storage and dispensing of learning units and performance evaluation units is best managed by using a set of file drawers with well organized compartments. One student, in charge of Tote-Trays (also checks the inventory list on the front of each tray against the contents) can distribute all materials and equipment as needed. References can also be distributed by the same student with little loss or damage to such items. A small corner of the shop, properly organized, will adequately serve the purposes of storage and distribution of tools, supplies, references, and learning materials. Check-out slips will likely be necessary for proper control.

A study carrel should be included as a part of the shop equipment. This serves as a station for some of the audio-visual materials required as references. Many students prefer to use the carrel for the short reading assignments, paper-pencil test items and the checking of vehicle specifications. Dirt and grease have not been a problem with such an arrangement in the test program. Central location of the carrel contributed to better supervision of student activity. When clean study areas are conveniently located, students seem more inclined to keep references clean. Also recommended in the line of shop furniture, is a stand-up type service desk. The desk provides a functional place for checking evaluations and recording performance data. Continous visual observation of class activity will be possible if furniture and equipment are properly positioned.

It will be necessary for the instructor to maintain some security on the self-scoring response cards. While the correct answer codings vary with each unit, cheating is possible.

The instructor should prepare a master student progress chart for both learning units and performance evaluations. This should be maintained at the service desk with dates shown for completed work. It is essential that the progress chart be up-to-date at all times.

Starting the School Year

Shop organization must be the first step. No attempt should be made to test any one unit without all of the tools, materials, training aids and references for that unit properly placed and marked. Also, one of the early tasks for personnel working with the program, should be a careful analysis and review of this report. No learning unit or performance evaluation should be given to student without having been examined first and carefully checked against training aids and required shop activity. Special attention here should be given the evaluation criteria as outlined on the instructor checklist.

The first meeting with students usually deals with school business, lockers, shop tours, rules, etc. However, the first or second day should also include some information about the new course. A brief verbal explanation of the rationale and a discussion of the program and operation is recommended. Occupational information and parts of the job description and task enumeration (excluding behavioral objectives) should be reproduced and made available to the students (See Appendix B, C, D and E). Here, one must be very careful to identify the purpose of the organization and emphasize the more advanced training levels. The program is not intended to train service station attendants (although some students will never progress beyond that level). The intention is to allow students to advance as far and as fast as they are capable and willing. Information on the related job families and the types of occupations one may qualify for as he progresses up the training hierarchy should be emphasized. Sample learning units and performance evaluations should be distributed along with the response cards for discussion and explanation.

Student orientation should also include a discussion of the Occupational Readiness Record (See Appendix J) and the list of organized activities (See Appendix K). An explanation is included with the Occupational Readiness Record describing its purpose and the grading system. Each student should have a copy of the activities list in his notebook. This should be kept up-to-date. The student must understand that the instructor will check the student's personal progress record (checklist of activities) frequently.

Performance Evaluations

The performance evaluations form the backbone of the course as designed. The standards are plainly stated and should not be "fudged" by the students, nor altered (without sound evidence) by the instructor. Note in the sample, (See Appendix G) that various prerequisite activities are suggested. The instructor options are especially critical and must be frequently exercised if the philosophy and the objectives of individualized instruction are to be met.

The instructor should make every effort to identify students who have had prior experience with various tasks. Such students should then be allowed to demonstrate proficiency on specific tasks via performance evaluations. This is considered a part of diagnostic testing and should be the major vehicle for establishing the student's level of capability and his starting point in the course. In many ways, the activities within the performance evaluations parallel what is commonly known to vocational educators as the "practical" exam. Paper-pencil tests cannot evaluate important aspects of shop performnnce--there is no substitute to actual performance. Care must be taken in the diagnostic testing to insure that students do not jeopardize the safety of themselves and others or damage equipment and vehicles.

After reading and completing necessary activities as outlined on the first page of the performance evaluation, the student should complete and discuss with the instructor, the written exam. Note that the instructor checklist states that the student must pass 80% of all such test questions. Discretion must be exercised here. The 80% figure is intended only as a guideline. The results of the written test should be analyzed--especially those items related to safety. The test may indicate that additional instruction (e.g. a learning unit) is necessary before the student is allowed to complete the performance evaluation. The discussion and analysis of test items may clear up some minor problems which will allow the student to progress, without further delay, in his shop work evaluation.

Note that additional instructor check points are provided throughout the laboratory activity. Most check points are related to safety, supervision, and critical evaluation activities. Students must not be allowed to advance past stop points without the services of the instructor as indicated. Check points may also reveal areas in which additional instruction and practice are necessary. Also the instructor should, as a part of such supervisory activities, complete appropriate sections of the instructor checklist. When the student has completed the work, the instructor checklist should be finalized. After the master progress record is marked, a new assignment can then be determined.

Groups of students with varying backgrounds of experience and knowledge in the subject area are usually readily identifiable. Some students will require a learning unit or other instruction prior to attempting the performance evaluation in nearly all of the organized activity. For others, only a brief review of the learning unit or references will be necessary to recall the safety and job procedures required to successfully complete the performance evaluation. Some students will "test out" of the basic program and into the second level in a matter of weeks. Others will require months to demonstrate a minimum level of proficiency.

It is important to understand that all students are not to be forced through all learning units and prerequisite readings irrespective of background, capability, and potential to successfully perform. (Several excellent references are available on individualizing instruction, student motivation, and topics related to those reflecting the design of the program described in this report.)

Learning Units

The learning units serve an essential and functional purpose. They permit the teacher to structure and operate a program of instruction quite different from that any of the students had previously experienced. Early attempts by the Project, to use abbreviated learning units or guides failed to result in operational programs. (Other factors affecting Project development and implementation have been documented in the Eighth Quarterly Technical Report.) Critical to the Power Mechanics program, however, was the availability of the step-by-step instructional materials. Some units, such as those on washing and waxing vehicles or body lubrication, may be used by only a few of the students. Other activities, such as chassis lubrication, are quite complex for the first job level. Most students will likely need the highly structured learning units with the more advanced and difficult projects.

Note that nearly all units identify optional readings and references which offer considerably more breadth and information than the basic learning unit. Through such options, related science and math or various enrichment activities are available to those students wishing to take advantage of the opportunity. The learning units by design, have been prepared in the briefest form possible and include only that essential information needed to achieve the unit objectives. To reiterate, the learning units and performance evaluations are not intended to be the sole source of student experiences. Other resources must be utilized if one is to effectively meet the needs of individuals and to accomodate the varying learning styles and preferences.

The overview is intended to clarify the objective and to explain why the task and the standards established for that task are important. Even though overviews are brief, many students tend to skip the first page and go directly to lab activity section. Furthermore, students will have a tendency not to carefully examine the job standards detailed for such review in the instructor's checklist. The teacher should make every effort to see that students carefully examine the job standards prior to attempting any shop work. They should be encouraged to read the overview and the list of equipment required for the job.

Some instruction will be necessary with use of the response cards. Some students will be confused occasionally by the change of coding for the right answer. The coding varies from one unit to another.

To conclude, it is the opinion of the instructors who have worked with the program, that the techniques which have been developed for Power Mechanics have resulted in a number of improvements over the courses previously available in their department. The instructors claim an improvement in student discipline and attitudes (with only a few notable exceptions). They also claim that the students have appeared more confident in their lab activities and more self-reliant as a result of the emphasis placed on making the student responsible for his own learning. The staff has also cited evidence that their students demonstrate more initiative to work on their own and to utilize more effectively, shop manuals and service guides to solve various problems and questions. It was also stated that the students seemed more aware of job standards, and were more willing to accept such standards and work to those standards. Response to open-ended reaction forms administered to students have been surprisingly positive. In the event of an expanded field test and validation program, instructor and student reactions and comments should be a part of the data collection. Opinion and preference scales are available and could be quite helpful.

RECOMMENDATIONS

1. Evaluation of the total program as a fully operational curriculum should be conducted and properly reported. Included as a part of the evaluation should be a comparison of ABLE and non-ABLE students on: (a) achievement and performance; (b) attitudes toward school; (c) attitudes toward subject and method of instruction, and (d) attendance. Each unit should again be tested with the aid of the instructor checklist instrument. An item analysis of all test questions and responses should be conducted.
2. A complete manual with all necessary instruments and procedures identified, should be prepared for the proposed evaluation. Procedures for long term evaluation and validation should be included.
3. An appropriate evaluation will require a test population of adequate size. Furthermore, a broader geographic distribution will be required if validity and reliability of test results are to be assured. Since Quincy is a member of the ES'70 system, it is therefore recommended that selected schools within the ES'70 system be encouraged to participate in a field testing and validation program of the Project ABLE Power Mechanics products.
4. The proposed experimental programs should be considered pilot demonstration projects with the additional objectives of acquainting vocational school instructors and administrators with training systems of the type described in this report. The proposed programs should also serve the function of training local school staff in the procedures of developing, implementing and evaluating systematized programs of individualized instruction. Inservice training on the processes of individualizing instruction should be initiated and carried through.
5. Quincy and other school systems participating in the proposed field test, should make every effort to establish the program as an exemplary demonstration model. This means equipping

with appropriate audio-visual materials and equipment, training aids and mock-ups, references, furniture and shop equipment, etc.

6. Development of the second level Power Mechanics program should be initiated. Performance evaluations with the detailed instructor's checklist, should be provided. An occupational readiness record, activities list, and documents such as the job description and task analysis, should be completed and reported. Learning units should not be developed unless it is determined that the program could not function without such materials. (It is hoped that the carefully structured first level program will have conditioned the students and teachers to the behaviors required to successfully interact with a program of individualized instruction utilizing a variety of resource materials. However, available commercial publications may prove inadequate to the point where special learning materials would again need to be developed.) The materials, as developed, should be made available to schools cooperating in an expanded test of the Power Mechanics program.
7. Copies of the technical report should be made available to member ES'70 school systems. The report should be published through ERIC. Such distribution should be considered adequate to fulfill contractual obligations for dissemination of Project ABLE products.
8. All Project ABLE Power Mechanics materials should be made available to Project PLAN (AIR and Westinghouse Learning Corp.) for consideration as part of the PLAN computer assisted instructional system. (Quincy is a member of the Project PLAN test group.)
9. The Project ABLE Power Mechanics materials should be considered by USOE for the extension of limited copyright privileges to a commercial publisher. The grantee should have had experience in individualized instructional programs utilizing the "hands-on" approach such as that described in this

report. The grantee would be expected to invest funds in the development of an attractive and functional set of materials typical of commercial quality in printing, illustrations, and various audio-visual aids.

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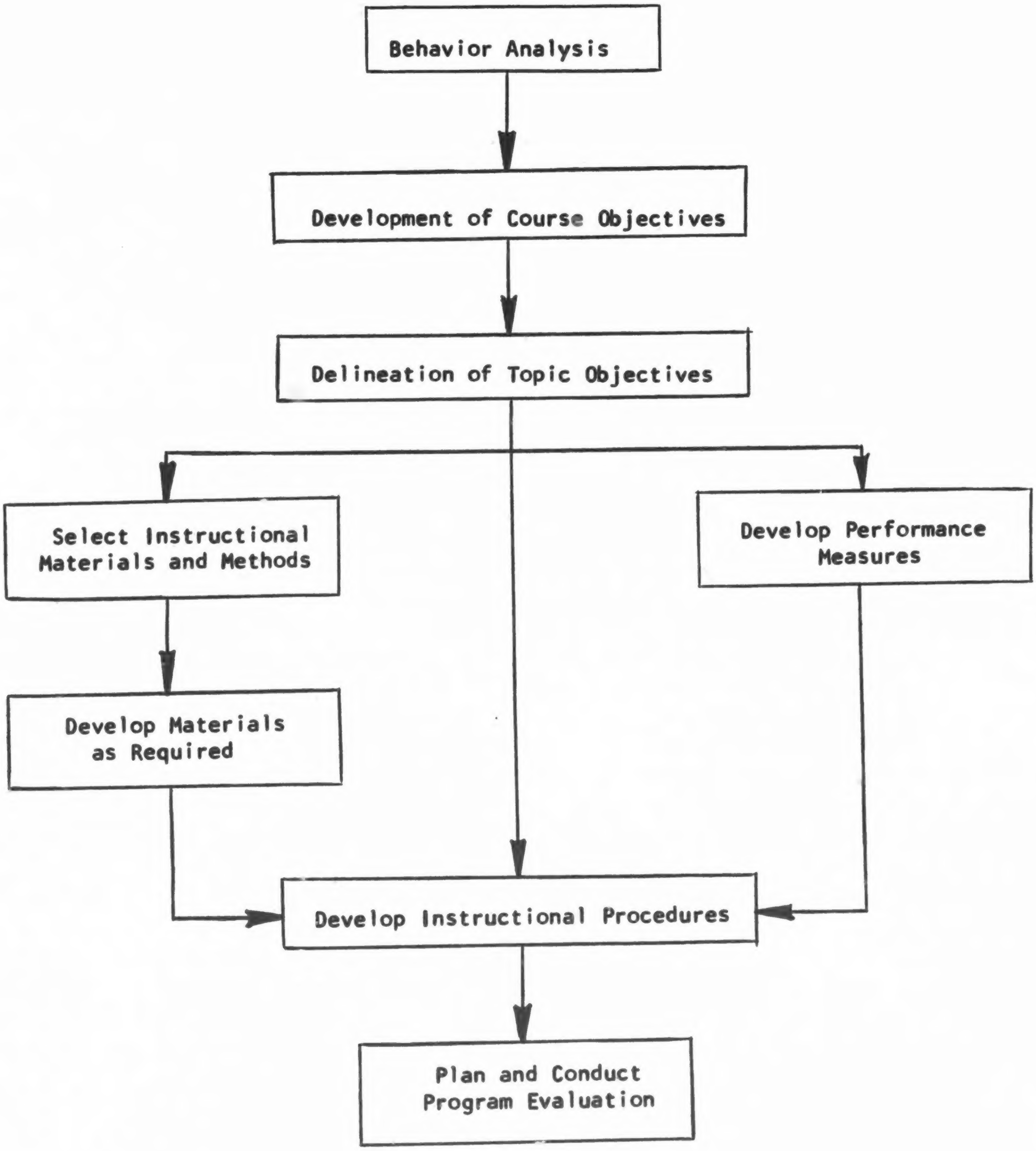
APPENDIX A

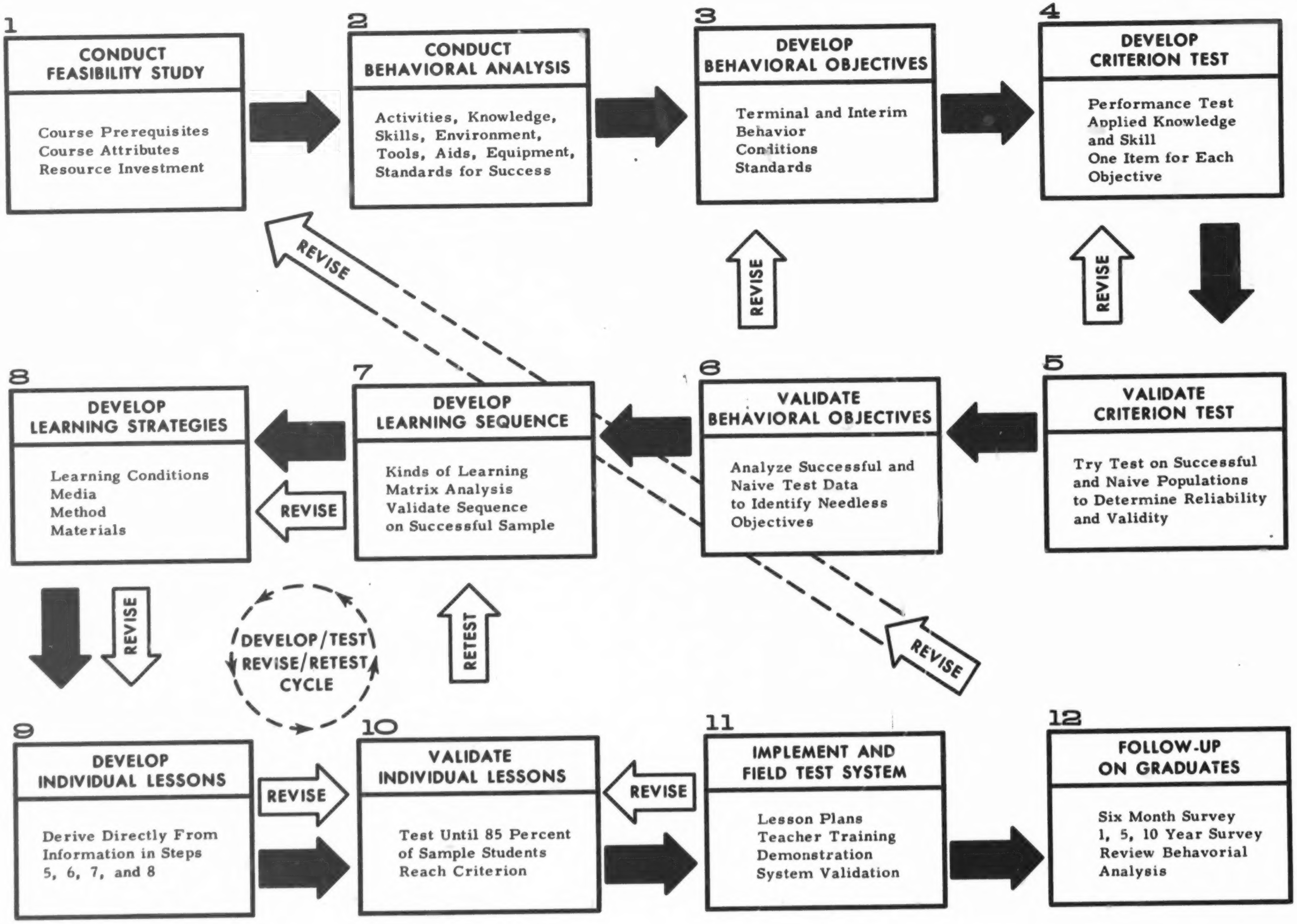
CURRICULUM DEVELOPMENT FLOW CHARTS


Behavior Analysis
Development of Course Objectives
Delineation of Topic Objectives
Select Instructional Materials and Methods
Develop Performance Measures
Develop Materials as Required
Develop Instructional Procedures
Plan and Conduct Program Evaluation

Overview of Steps in Curriculum Development and Evaluation*

*Suggested procedures from original Project ABLE proposal

FLOW CHART OF TRAINING SYSTEM DEVELOPMENT PROCESS*


1
CONDUCT FEASIBILITY STUDY
Course Prerequisites
Course Attributes
Resource Investment
2
CONDUCT BEHAVIORAL ANALYSIS
Activities, Knowledge, Skills, Environment, Tools, Aids, Equipment, Standards for Success
3
DEVELOP BEHAVIORAL OBJECTIVES
Terminal and Interim Behavior
Conditions
Standards
4
DEVELOP CRITERION TEST
Performance Test
Applied Knowledge and Skill
One Item for Each Objective
REVISE
REVISE
REVISE
5
VALIDATE CRITERION TEST
Try Test on Successful and Naive Populations to Determine Reliability and Validity
6
VALIDATE BEHAVIORAL OBJECTIVES
Analyze Successful and Naive Test Data to Identify Needless Objectives
7
DEVELOP LEARNING SEQUENCE
Kinds of Learning
Matrix Analysis
Validate Sequence on Successful Sample
8
DEVELOP LEARNING STRATEGIES
Learning Conditions
Media
Method
Materials
REVISE
REVISE
DEVELOP/TEST REVISE/RETEST CYCLE
RETEST
REVISE
9
DEVELOP INDIVIDUAL LESSONS
Derive Directly From Information in Steps 5, 6, 7, and 8
REVISE
10
VALIDATE INDIVIDUAL LESSONS
Test Until 85 Percent of Sample Students Reach Criterion
REVISE
11
IMPLEMENT AND FIELD TEST SYSTEM
Lesson Plans
Teacher Training
Demonstration
System Validation
12
FOLLOW-UP ON GRADUATES
Six Month Survey
1, 5, 10 Year Survey
Review Behavorial Analysis

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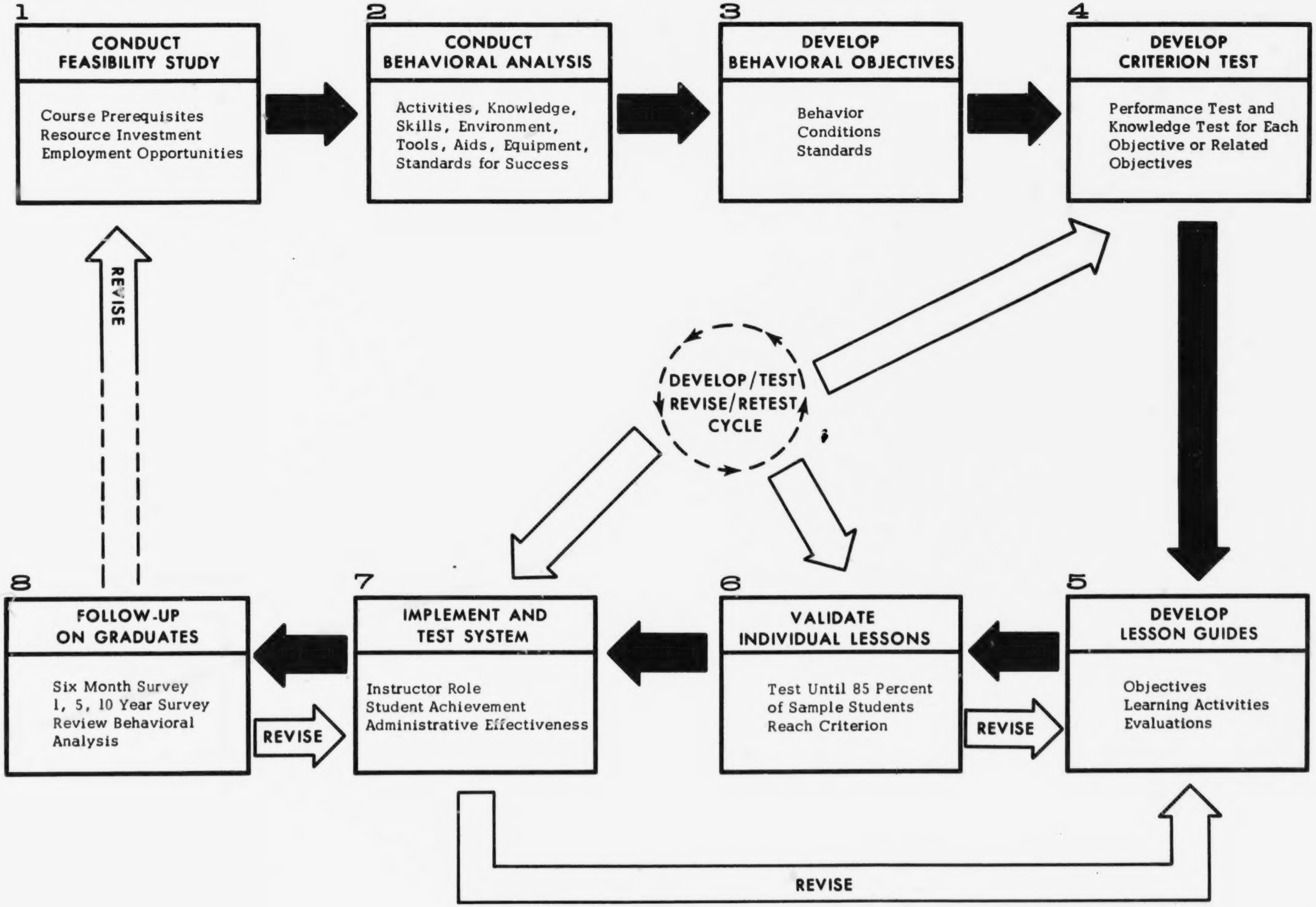
*Preferred model to that presented in original proposal.

PROJECT ABLE

FLOW CHART OF TRAINING SYSTEM DEVELOPMENT PROCESS


1
CONDUCT FEASIBILITY STUDY
Course Prerequisites
Resource Investment
Employment Opportunities
2
CONDUCT BEHAVIORAL ANALYSIS
Activities, Knowledge, Skills, Environment, Tools, Aids, Equipment, Standards for Success
3
DEVELOP BEHAVIORAL OBJECTIVES
Behavior
Conditions
Standards
4
DEVELOP CRITERION TEST
Performance Test and Knowledge Test for Each Objective or Related Objectives
DEVELOP/TEST REVISE/RETEST CYCLE
5
DEVELOP LESSON GUIDES
Objectives
Learning Activities
Evaluations
6
VALIDATE INDIVIDUAL LESSONS
Test Until 85 Percent of Sample Students Reach Criterion
7
IMPLEMENT AND TEST SYSTEM
Instructor Role
Student Achievement
Administrative Effectiveness
8
FOLLOW-UP ON GRADUATES
Six Month Survey
1, 5, 10 Year Survey
Review Behavioral Analysis
REVISE
REVISE
REVISE
REVISE

APPENDIX B

JOB TITLE ENUMERATION

JOB TITLE ENUMERATION

POWER MECHANICS

	SELECT		
JOB NAME	Yes	No	REASON
Automobile accessories installer		/	#3
Automobile analyst		/	#3
Automobile body-parts assembler		/	#3
Automobile metalman, helper	/		
Automobile body repairman, metal	/		
Automobile body repairman, wood		/	#3
Automobile body worker	/		See #5
Automobile car loader		/	#3
Automobile collision serviceman		/	#3
Automobile fuel pump repairman		/	#3
Automobile generator repairman		/	#3
Automobile starter repairman		/	#3
Automobile headlight assembly		/	#3
Automobile inspector		/	#3
Automobile light assembler		/	#3
Automobile maintenance mechanic	/		See #89
Automobile mechanic	/		See #89
Automobile mechanic, bench	/		See #89
Automobile mechanic, motor	/		See #89
Tank motor service mechanic		/	#3
Automobile mechanic apprentice	/		
Automobile mechanic assistant	/		See #90
Automobile mechanic, chief		/	#3
Automobile mechanic, diesel engine			See #93
Automobile mechanic, foreman		/	#3
Automobile mechanic, helper	/		See #90
Automobile mechanic, motor repairman	/		See #89
Automobile mechanic, radiator man		/	#3
Automobile parker (parking lot attendant)	/		See #37
Automobile polisher	/		See #37
Automobile race driver		/	#3
Automotive service station mechanic	/		
Automobile repairman	/		See #89
Automobile repair serviceman	/		See #89
Automobile sealer		/	#3
Automobile service mechanic	/		See #89
Automobile service station attendant	/		
Automobile spring repair		/	#3
Automobile taillight assembler		/	#3
Automobile tester		/	#3
Automobile vehicle safety inspect.	/		See #32
Automobile Underwriter		/	#3
Automobile convertible top and upholsterer		/	#3

	SELECT		
JOB NAME	Yes	No	REASON
Automobile body trimmer		/	#3
Automobile upholsterer apprentice		/	#3
Automobile washer	/		See #37
Automobile washer, straw		/	#1
Automobile woodworker		/	#3
Automobile wrecker		/	#3
Automotive department foreman		/	#3
Automotive engineer		/	#3
Automotive maintenance equipment repairman		/	#3
Automotive maintenance equipment serviceman		/	#3
Automotive maintenance foreman		/	#3
Automotive trouble-shooting mechanic	/		See #89
Dynamometer tuner	/		See #89
Automotive section chief		/	#3
Automotive test engine mechanic		/	#3
Automotive test engine mechanic foreman		/	#3
Automotive test shop supervisor		/	#3
Automotive test vehicle chassis mechanic		/	#3
Automotive test vehicle chassis foreman		/	#3
Automotive tester		/	#1--3
Automotive tester foreman		/	#3
Auto parts inspector		/	#3
Carburetor inspector		/	#3
Motor and chassis inspector		/	#3
Spring inspector		/	#3
Auto collision estimator		/	#3
Auto repairman helper	/		See #90
Auto seat inspector		/	#3
Service manager		/	#3
Automobile collision serviceman		/	#3
Automobile, body, and fender repairman	/		See #5
Automobile body line finisher		/	#3
Steam cleaner	/		See #90
Automobile body dent remover	/		See #5
Automobile body dingman	/		See #5
Automobile glass installer		/	#3
Automobile body hammer out man	/		See #5
Automobile body metal bumper	/		See #5
Automobile body metal shrinker	/		See #5
Automobile body metal worker	/		See #5
Automobile body touch-up finisher	/		See #87
Automobile body welder, acetylene	/		See #5
Automobile body welder, arc		/	#3
Automobile painter (spray)	/		
Automobile body painter helper (spray)	/		
A. R. auto mechanic	/		
A. R. auto mechanic helper	/		
A. R. truck and bus mechanic		/	#3
A. R. truck and bus mechanic's helper		/	#3

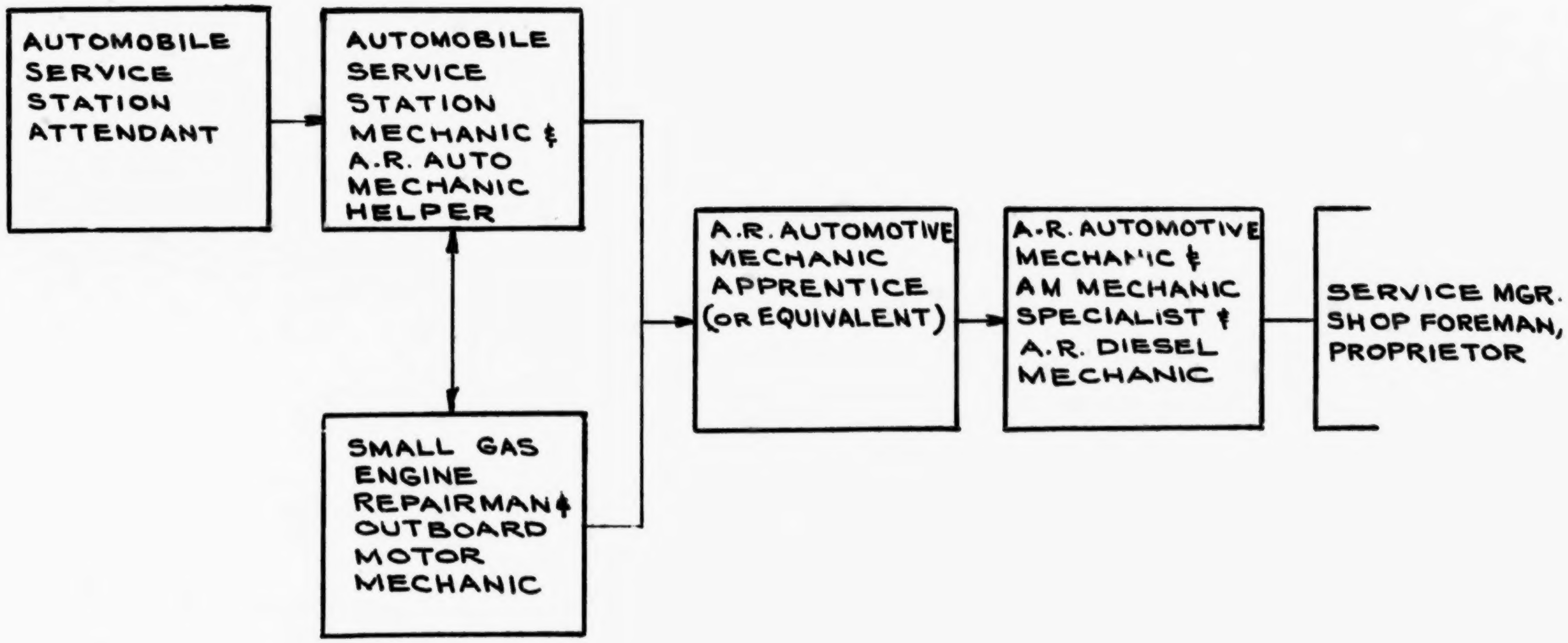
	SELECT		
JOB NAME	Yes	No	REASON
A. R. diesel (pass) mechanic (tune-up)	/		
Fuel injection pump man, Diesel		/	#3
Foreign car mechanic	/		See #89
Automotive front-end man	/		
Automotive, chassis and springs		/	#3
Automotive, brake man	/		See #89
Automotive eng. tune-up specialist	/		
Automotive carburetion specialist	/		
Automotive electrician, starter and generators	/		
A. M., automatic trans. mechanic		/	#3
A. M. automotive trans. installer		/	#3
A. M. new car prep man		/	#3
A. M. installer of exhaust systems	/		See #32
A. M. power steering and P brakes	/		
A. M. lube man	/		See #37
A. M. automotive machinist		/	See Machines Voc. Area
A. M. engine R & R man	/		See #90
Parts jobber counterman	/		See #90
Automotive service salesman		/	#3
A. M. air conditioning man		/	#3
A. M. air supervision man		/	#3
Small gas engine repairman	/		
Diesel truck and bus mechanic	/		See #95
Outboard motor mechanic	/		
Air brakes		/	#3
Metalman helper and painter helper (comb.)	/		
Body repairman apprentice	/		
Painter apprentice	/		
Spray gun repairman	/		See #122
Body repairman and painter (comb.)	/		
Body repairman apprentice (comb.)	/		
Small gas engine repairman, helper	/		
Outboard motor mechanic, helper	/		
Motorcycle repairman	/		See #89
Tire repairman	/		See #37
Tire rebuilder		/	#3
Alignment man or mechanic	/		See #96
Axle and frame man	/		See #96
Chassis mechanic	/		See #96
Frameman	/		See #96
Tractor mechanic	/		See #115
Truck equipment mechanic	/		See #115
Aircraft mechanic or repairman		/	#3
Farm machinery mechanic or repairman		/	#3
Engine, power transmission and related mechanics	/		See #89
Body masker			
Automobile upholsterer			

APPENDIX C

OCCUPATIONAL FLOW CHART AND SELECTED LIST OF OCCUPATIONS: AUTO MECHANICS

POWER MECHANICS

(Automotive Mechanics and Related Occupations)


AUTOMOBILE SERVICE STATION ATTENDANT
AUTOMOBILE SERVICE STATION MECHANIC & A.R. AUTO MECHANIC HELPER
SMALL GAS ENGINE REPAIRMAN & OUTBOARD MOTOR MECHANIC
A.R. AUTOMOTIVE MECHANIC APPRENTICE (OR EQUIVALENT)
A.R. AUTOMOTIVE MECHANIC & AM MECHANIC SPECIALIST & A.R. DIESEL MECHANIC
SERVICE MGR. SHOP FOREMAN, PROPRIETOR

NOTE: See list of occupations for a more detailed compilation of jobs and job families.

POWER MECHANICS

(Automotive Mechanics and Related Occupations)

Selected List of Occupations

AUTO MECHANICS

*Automobile Service Station Attendant	915.867
Automobile Self-Service Station Attendant	915.878
Gas and Oil Man	915.587
Steam Cleaner	915.887
Taxi Serviceman	915.878
Lubrication Man	915.867
Tire Repairman	915.867
Brake adjuster	915.867
Auto slip-cover installer	915.887
Tire inspector	750.687
Tire Mounter	750.887
*Small Gas Engine Repairman	625.281
Outboard Motor Mechanic	623.281
Outboard Motor Tester	625.281
Motorboat Mechanic	623.281
Small Gas Engine Repairman, Helper	625.284
Motorboat Mechanic, Helper	623.884

*Representative Occupations

*Automobile Service Station Mechanic	620.381
A.R. Auto Mechanic Helper	620.884
Car Checker (ret. tr.)	806.281
Tire Service Foreman	915.134
Tire Repairer	750.781
Motorcycle Tester	620.384
Body Wireman	829.684
Battery Inspector	829.684
Electrician Helper, Auto	729.884
Brake Adjuster	620.884
Clutch Rebuilder	620.884
Constr. Equip. Mechanic Helper	620.884
Engineering Equip. Mechanic Helper	620.884
Motorcycle Subassembler Repairman	620.884
Spring Repairman Helper, Hand	620.884
Tractor Mechanic Helper	620.884
Used Car Renovator	620.884
Auto-Wrecker-Wrecking Mechanic	620.884
Motorcycle Assembler	806.884
Motor-Vehicle-Light Assembler	824.884
Automotive Parts Man	223.387
Parts-Order or Stock Clerk (Motor Trans.)	223.387
Tool Clerk	223.387
New Car Inspector	919.387
Motor Assembler	721.887
Internal Combustion Engine Assembler, Helper	801.887
Motor Test Helper	806.887

*A.R. Automotive Mechanic Apprentice	620.281
Aircraft and Engine Mechanic, Helper	621.884

*Representative Occupations

*A.R. Automotive Mechanic	620.281
Differential Repairman	620.281
Drive Shaft and Steering Part Repairman	620.281
Engine Head Repairman	620.281
Engine Repair Mechanic	620.281
Brakeman	620.281
Carburetor Man	620.281
Front-End Man	620.281
Transmission Man	620.281
Tune-Up Man	620.281
Automotive Repair Service Salesman	620.281
Motorcycle Repairman	620.281
Mechanic, Industrial	620.281
Mechanical-Maintenance Man (any ind.)	620.281
Automotive-Maintenance-Equipment Serviceman	620.281
Air Conditioning Mechanic	620.281
Automotive Tester	620.281
Construction-Equipment Mechanic	620.281
Motor and Chassis Inspector (auto mfg.)	620.281
Tractor Mechanic (any ind.)	620.281
Mechanical Unit Repairman	620.381
Repairman Heavy	620.381
Automobile Radiator Repairman	620.381
Brake Drum Lathe Operator	620.782
Aircraft and Engine Mechanic Apprentice	621.281
Engine Repairman Production (engine and turbine)	675.381
Internal Combustion Engine Subassembly	706.781
Electric-Motor Repairman	721.281
Automotive-Generator and Starter Repairman	721.281
Electrician Automotive	825.281

*Diesel Mechanic (any ind.)	625.281
Diesel Engine Mechanic, Automotive	625.281
Diesel Engine Mechanic, Bus	625.281
Diesel Engine Mechanic, Marine	625.281
Diesel Engine Mechanic, Construction	625.281
Diesel Engine Mechanic, Farm	625.281
Locomotive Repairman, Diesel	625.281
Diesel Engine Tester	625.281
Diesel Engine Erector	625.381
Diesel Mechanic, Helper	625.884
Fuel Injection Serviceman (any ind.)	625.281

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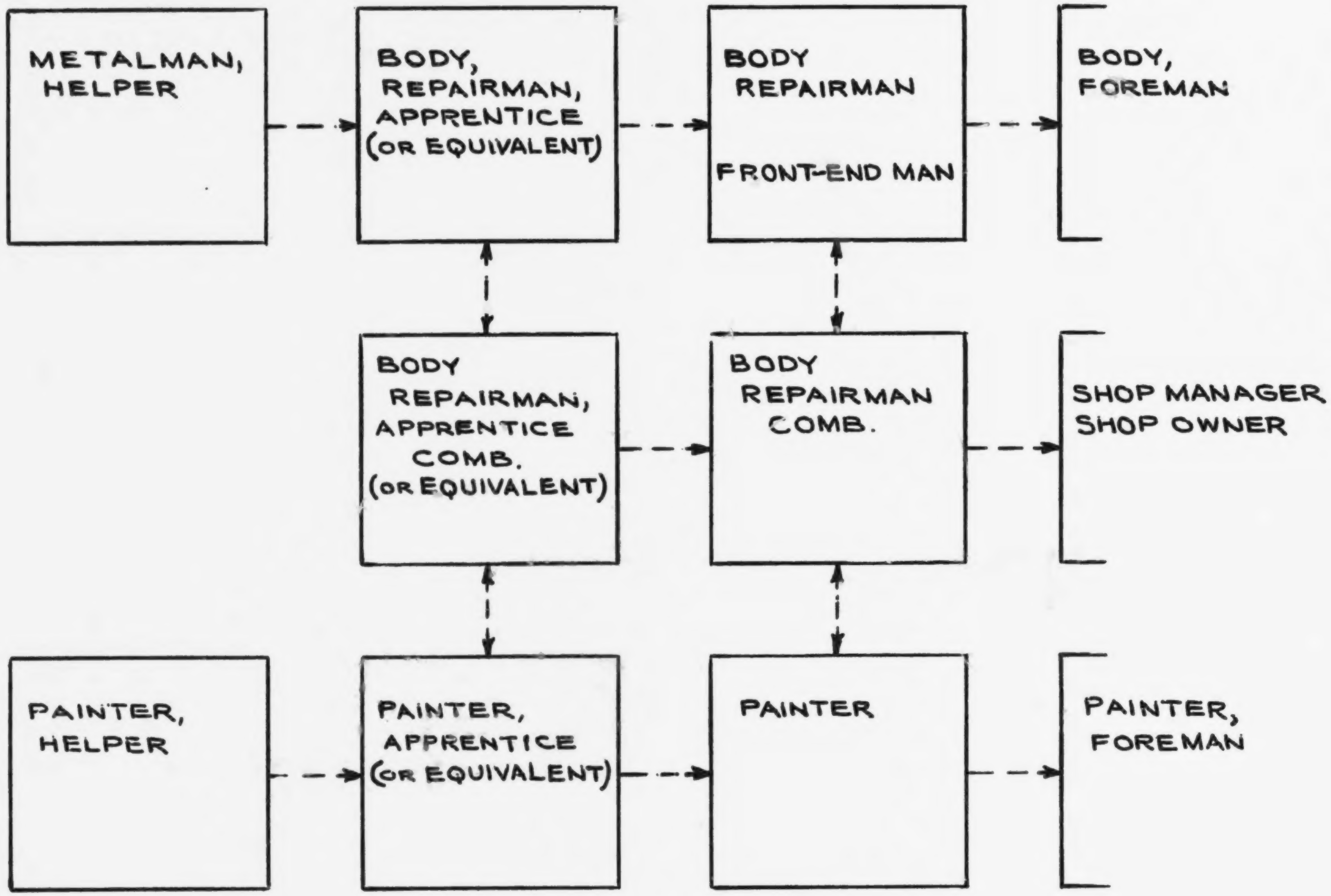
*Representative Occupations

APPENDIX D

OCCUPATIONAL FLOW CHART AND SELECTED LIST OF OCCUPATIONS: AUTO BODY

POWER MECHANICS

(Auto Body and Related Occupations)


METALMAN, HELPER
BODY, REPAIRMAN, APPRENTICE (OR EQUIVALENT)
BODY REPAIRMAN
FRONT-END MAN
BODY, FOREMAN
BODY REPAIRMAN, APPRENTICE COMB. (OR EQUIVALENT)
BODY REPAIRMAN COMB.
SHOP MANAGER
SHOP OWNER
PAINTER, HELPER
PAINTER, APPRENTICE (OR EQUIVALENT)
PAINTER
PAINTER, FOREMAN

NOTE: See list of occupations for a more detailed compilation of jobs and job families.

POWER MECHANICS

(Auto Body and Related Occupations)

Selected List of Occupations

AUTO BODY

*Body Repairman, Helper, Auto	807.887
*Painter, Helper, Auto	845.884
Painter, Helper, Spray (any ind.)	741.887
Painter, brush (any ind.)	740.887
Painter, Helper, Construction (any ind.)	780.887
Masker (any ind.)	749.887
Cleaner (any ind.)	919.887
*Body Repairman, Apprentice (or equiv.) Auto	807.381
Auto Bumper Straightener	807.884
Solderer, Torch (auto mfg.)	807.884
Auto Door Panel Assembler (auto mfg.)	806.884
Headliner Installer	806.884
Glass Installer	865.884
Buffer (any ind.)	705.884
Polisher (any ind.)	705.884
Metal Finisher (any ind.)	705.884
Auto Accessories Installer	806.884
Auto Seat-Cover & Convertible Top Installer	780.884
Metal--Finish Inspector (any ind.)	703.587
Metal Sander and Finisher (any ind.)	705.887
*Painter, Apprentice (or equiv.) Auto	845.781
Spray Gun Repairman	630.381
Painter, Spray (any ind.)	741.884
*Body Repairman, Combination, Apprentice (or equiv.) Auto	807.381

*Representative Jobs

*Body Repairman, Auto	807.381
Body Repairman, Bus	807.381
Service Mechanic	807.381
Truck Body Builder	807.281
New Car Get-Ready Man	806.381
Automobile Upholsterer	780.381
Automatic Window-Seat & Top-Lift Repairman	825.381
Welder, Gas	811.884
Dingman (any ind.)	809.884
*Front-End Man, Auto	620.281
*Painter, Auto	845.781
Painter, Aircraft	845.781
Painter, Shipyard	840.781
*Body Repairman, Combination, Auto	807.381
Shop Estimator	807.287

*Representative Jobs

APPENDIX E

JOB DESCRIPTION AND TASK ANALYSIS -- FIRST LEVEL

POWER MECHANICS

Service Station Attendant D.O.T. #915.867

A. Defining the Population

The majority of service station attendants are employed in leased or independently owned service stations. Most service station attendants are trained on-the-job although short term formal training conducted by major oil companies is available. On-the-job training time varies from 30 days to three months. Personal characteristics and dependability, according to the D.O.T., are among the more significant points an employer will look for in a potential beginning employee.

Excluded from this definition are:

1. Service station mechanics who are primarily concerned with performing minor (and in some instances major) automotive repairs and adjustments.
2. Service station owners or managers who are primarily concerned with management procedures of a service station.

B. Statement of Mission

The primary mission of a service station attendant is:

1. Servicing motor vehicles and automotive equipment.
2. Selling products offered by his establishment.

Other secondary missions are:

1. Cleaning and various custodial type duties.
2. Assisting the owner, manager or mechanic in a variety of minor tasks.

Job contexts for the service station attendant are quite varied depending on the establishment in which he is employed. In most cases, he will be required to service foreign vehicles, take part in company promotional programs, diagnose minor malfunctions, give directions to travelers, and clean the service station area. In addition, in certain states, he may assist in performing state automobile safety inspections. He may also assist the service station mechanic in performing minor repairs. The attendant works inside and outside under varied weather conditions.

The physical demands require:

1) crouching, such as bending the body downward and forward by bending the legs and spine;

2) feeling, such as perceiving such attributes of objects and materials as size, shape, temperature, or texture, by means of receptors in the skin, particularly those of the finger tips;
3) color vision, such as the ability to identify and distinguish colors.

The attendant is required to make arithmetic calculations involving fractions, decimals, and percentages.

C. Functions and Components of Functions

Things	Data	People
Handling	Copying	Taking Instructions - Helping
Manipulating	Computing	Servicing
Operating-Controlling	Compiling	Exchanging Information

The things the service station attendant handles and manipulates are various hand tools and automotive parts, components and merchandise. He operates-controls various dispensing and service equipment such as gas pumps and grease guns. The data functions with which the attendant is concerned are computing costs of services (e.g. gas, oil, lube, etc.), compiling various types of information obtained from manuals and simple inspections of motor vehicles. He will analyze data, usually with assistance and supervision, in order to determine what necessary actions are to be taken to complete his mission. He will perform simple clerical chores such as recording information on gas pump sales. The mechanic's relation with people involve taking instructions or receiving information from customers and supervisors, helping fellow workers when necessary, and speaking to and signalling fellow workers or customers in order to convey information to them.

D. Segments

The main steps involved in the occupation of service station attendant are identifying customer needs, selling products, performing required service operations, and receiving payment for products and services.

E. Contingencies and Contexts

1. May have to perform emergency road service.
2. May have to keep records and inventories.
3. May have to order materials and supplies.
4. May have to rent trailers, trucks, and other vehicles.
5. May have to assist service station mechanic.
6. May have to assist in arranging displays.
7. May have to substitute floor jacks in raising motor vehicles when hydraulic lift is not available.

F. Task Classification

a. Basic Tasks

1. Identifies customer needs.
2. Dispenses fuel.
3. Checks oil level.
4. Checks water level.
5. Adds required fluid or oil.
6. Inspects battery.
7. Performs battery services.
8. Tests tire pressure.
9. Adjusts tire pressure.
10. Removes and replaces tires.
11. Repairs tires.
12. Lubricates.
13. Services spark plugs.
14. Replaces light bulbs and fuses.
15. Replaces drive belts.
16. Replaces filters.
17. Receives credit and cash payments.
18. Cleans service station area.
19. Keeps records and inventories.
20. Washes and polishes automobiles.
21. Services cooling system (minor).
22. Performs preventive and safety maintenance checks.

b. Advanced Tasks

1. Services front wheel bearings.
2. Services exhaust system.
3. Adjusts brakes.
4. Replaces shock absorbers.
5. Balances wheels.
6. Services windshield wipers.

A number of other basic and simple tasks included as a part of the description for Service Station Mechanic could be included as advanced tasks.

c. Speciality Tasks

1. Tire recapping.
2. Battery repair.
3. Body repair.
4. Exhaust system repair.

d. Ancillary Tasks

1. Cleaning various components and parts.
2. Some replacement tasks (these consist of removing or unfastening the component or part to be replaced and installing [reverse of removing] the replacement part or component).

e. Redundant Tasks

1. Removal of nuts, bolts and screws.
2. Turning of handles and knobs (e.g. gas pumps).
3. Some removal and replacement tasks (e.g. gas caps).

G. Task Analyses (in the form of course and topic objectives)

Task 1. Identifies customer needs.

CO 1. Given a customer, the student identifies needs by asking him what is required for his automobile.

TO 1. Given a prospective gasoline customer, student identifies make and model of automobile to determine location of fill pipe and grade of fuel recommended, in the time that it takes him to walk smartly from building to pump island.

TO 2. Given a gas customer, student states ways and means he can use to persuade customer to allow him to perform routine under hood checks.

CO 2. Given a customer's automobile, the student identifies minor deviations from standard car operation.

TO 1. Given a variety of automobile makes and models, student locates cooling, lubricating, ignition, and fuel systems, and primary parts.

Task 2. Dispenses fuel.

CO 1. Given a customer's automobile, student fills to specified level without spilling, damaging car surface, or violating safety practices.

TO 1. Given gas pump and customer's automobile, student sets pump at zero reading, turns on pump, fills tank to desired level, maintaining a metal to metal contact between nozzle and fill pipe, and replaces pump nozzle, without spilling or damaging car surface.

Task 3. Checks oil level.

CO 1. Given an automobile, student locates dip stick, observes oil level, and determines oil requirements to the nearest quart.

TO 1. Given an automobile, the student lifts the hood, selects the oil dip stick by differentiating it from the transmission dip stick.

TO 2. Given a located oil dip stick, student relates the oil level requirements to the nearest quart.

TO 3. Given a car requiring additional oil, the student determines the appropriate type of oil for engine by asking the customer, referring to service sticker and/or checking appropriate manual.

TO 4. Given various types of car engines and various grades of engine oil, student identifies appropriate engine oil by taking into account grade, weight, season, viscosity, and engine mechanical condition.

CO 2. Given automobile with engine running, student locates automatic transmission dip stick, observes oil level, and determines oil requirements to the nearest pint.

TO 1. and TO 2. - See Task 3 CO 1., TO 1., and TO 2., using auto transmission fluid.

TO 3. Given samples of engine oil and ATF, the student differentiates between engine oil and transmission fluid by their properties and functions.

CO 3. Given power steering reservoir, student determines required level of fluid by visual observation or use of dip stick.

TO 1. Given a power steering reservoir, determines the proper level marking and relates oil level to observed marking.

Task 4. Checks water level.

CO 1. Given car radiator, student identifies coolant level by removing radiator cap in a safe manner and visually observing coolant level.

TO 1. Given a car radiator, student identifies coolant level by releasing the pressure, removing the radiator cap, and visually observing the coolant level and condition.

Task 5. Adds required fluid or oil.

CO 1. Given an auto requiring fluid oil or coolant, the student locates the filler tube and adds the required type and amount of fluid, oil, or coolant.

TO 1. Given a car needing fluid or coolant, student locates the appropriate fill markings, adds fluid, and performs final checks to verify approximate level of fill.

Task 6. Inspects battery.

CO 1. Given car battery, student inspects electrolyte level, exterior condition, and cable connections.

TO 1. Given car battery, the student reads battery fill instructions on the battery, observes battery for cracks, corrosion and broken or loose cable connections.

CO 2. Given a battery and testing kit consisting of hydrometer and voltmeter, student identifies specific gravity reading and voltage reading.

TO 1. Given a hydrometer, student identifies it by appearance, function and operation.
TO 2. Given a voltmeter, student identifies it by appearance, operation, graduations and function.
TO 3. Given a six or twelve volt battery and voltmeter, the student identifies the positive and negative connecting straps for each cell, applies meter, and reads meter scale.

CO 3. Given visual inspection of car battery, student compares his inspection with accepted standards and determines what corrective measures should be taken.

TO 1. Given a hydrometer and automobile battery, the student determines condition by comparing specific gravity reading to specifications.
TO 2. Given a voltmeter and a battery, the student determines conditions by comparing voltage readings with specifications.

Task 7. Performs battery services.

CO 1. Given a battery requiring service, the student adds water to specified level, cleans terminals and cables, cleans battery exterior, tightens cable connections, charges, if necessary, or removes and replaces returning system to normal operating conditions.

TO 1. Given battery with low electrolyte level, adds distilled water to specified level.

TO 2. Given battery cable service kit, and corroded battery terminals, applies the tools and steps to restore good electrical connections.

TO 3. Given an unclean battery exterior, the student cleans and rinses with proper chemical for neutrolizing acid, restoring battery to new-like condition.

TO 4. Given a battery service kit and various types of battery connections, student identifies types of tools and procedures required to produce a good electrical connection.

TO 5. Given a battery requiring charging, student locates and differentiates positive and negative terminals and attaches charger leads to appropriate terminals.

TO 6. Given a battery to be replaced, student, using proper removal and replacement procedures, tools, and observing safety precautions, removes and replaces batteries without tipping or damaging the battery or car finish.

TO 7. Given a battery needing charging, and a battery charger, student follows charger operating instructions to determine time and rate of charge and restores battery to normal operating condition.

Task 8. Tests tire pressure.

CO 1. Given a tire, a tire pressure gauge, student takes pressure readings and compares with normal tire requirements.

TO 1. Given a tire pressure gauge, the student identifies its functions and operation.

TO 2. Given various tires, a tire pressure gauge and tire inflation specifications, the student measures tire pressures to the nearest pound and compares his readings with the specifications (including front vs. rear tires; low vs. high pressure, etc.).

Task 9. Adjusts tire pressure.

CO 1. Given a reading, compressed air supply and tire gauge, the student inflates or deflates tire, if required, to specified pressure level.

TO 1. Given various tires with inappropriate pressures, a compressed air supply and tire pressure gauge, the student inflates or deflates to within + or - one pound.

Task 10. Removes and replaces tires.

CO 1. Given a defective tire, student identifies nature and extent of defect such as puncture, abnormal wear, etc., and associates defect to recommended corrective procedures.

TO 1. Given a tire, the student compares the condition of the tire with normal standards.

TO 2. Given a tire with a defect, the student associates nature of defect with corrective procedures.

CO 2. Given a raising device such as hydraulic jack or hoist, and tools, the student raises the auto and removes the wheel.

TO 1. Given various types of autos and hydraulic jacks and hoists, student associates lift points with makes and models of cars, according to manufacturer's specifications and raises car so that car is secure and at proper height and level.

TO 2. Given a set of wheels and various wheel removing tools (lug wrench, impact wrench), student removes and replaces each wheel without damaging threads or car finish.

CO 3. Given a tire to be replaced, but in servicable condition, a lifting device and tools, the student positions the wheel on axle and tightens lugs or nuts securely.

TO 1. Given a wheel replacement job, a hydraulic jack or hoist, and wrenches, student attaches wheels (rotating if necessary), tightens the lug nuts until wheel is positioned and tightens each nut again until wheel is safely secured.

Task 11. Repairs tires.

CO 1. Given a removed wheel, a tire demounting machine, chalk, and hand tools, student marks tire position in relation to valve stem, positions tire on demounting machine, removes tire from the wheel and remounts the same or replacement tire.

TO 1. Given a tire, tools, and demounting machine, student follows operating instructions, marks tire position in relation to valve stem, and removes and replaces tire on wheel, without damaging the tire or wheel.

CO 2. Given a tube-type tire with severe puncture, student repairs puncture airtight.

TO 1. Given a tire with tube, tools, and demounting machine, the student follows operating instructions to remove tube, without further damage to tube while maintaining position for ease of locating puncture object.

TO 2. Given tube puncture or valve stem leak, student tests by inflating and submerging in water (or using soap-solution), locates leak, and marks location.

TO 3. Given a located puncture in a tube, student associates type of puncture or injury with recommended method of repair.

TO 4. Given a variety of tube-patch kits, and various punctured or leaky tubes, student follows repair kit instruction (hot and/or cold patch types) and restores to airtight condition.

TO 5. Given defective valve core, student identifies valve removing tool, removes and replaces valve core restoring to airtight condition.

TO 6. Given a punctured tube, a student locates and removes puncture object by placing tube over tire rim in original position, maintaining relationship between valve stem and chalk mark.

CO 3. Given patches, plug patch and a tubeless-type tire with severe puncture requiring internal repair, student applies required patch returning to airtight condition.

TO 1. Given tubeless-type tire requiring repair, student associates type of puncture with recommended repair methods required to restore tire to safe operating airtight condition.

TO 2. Given a variety of tire repair kits, tools, and materials, student identifies and follows necessary instructions to successfully repair leak.

Task 12. Lubricates.

CO 1. Given an auto to be lubricated, student locates lubrication points in front suspension, drive lines, steering linkages, power line, chassis assembly, under-the-hood, and body.

TO 1. Given a variety of autos to be lubricated, the student identifies lube manual section for a specific make, model, and year of car and follows service directions as listed.

CO 2. Given lubrication points, student applies required amount and type of lubricant according to lube chart specifications until retainers are filled or excessive lubricant appears around the retainers.

TO 1. Given an auto with lubrication points and a variety of lubricants, student differentiates the various types and grades of lubricants and associates with common use and application, driving conditions, and seasons.

TO 2. Given an auto to be lubricated and lubricants, student identifies proper tools and adapters to render complete lubrication.

TO 3. Given an auto to be lubricated and lube instructions, student identifies the level or need of lubricant and services accordingly.

Task 13. Services spark plugs.

CO 1. Given an auto with spark plugs, spark plug cleaner tester, spark plug wrench, and hand tools, student removes spark plug, cleans, adjusts tests, and replaces, if necessary, with new spark plug.

TO 1. Given an auto with spark plug to be removed or replaced, student identifies proper tools and performs operation (including tightening to torque specifications) without altering gap, damaging spark plug, stripping threads, and without foreign material entering engine.

TO 2. Given a set of spark plugs to be removed from engine, student maintains relationships between each plug and the engine cylinder in which it operates and the wire which fires each plug and cylinder in the proper sequence.

TO 3. Given a removed spark plug, student visually inspects plug, compares to chart of common malfunctions and deposits to determine operating condition of engine.

TO 4. Given a spark plug and a spark plug cleaner-tester, student locates and follows operating instructions to clean spark plug to a new-like condition.

TO 5. Given a clean spark plug, student adjusts gap to engine specifications and tests spark comparing to new plug according to test machine specifications.

TO 6. Given a spark plug to be replaced and a spark plug catalog, student identifies and secures equivalent replacement part.

Task 14. Replaces light bulbs and fuses.

CO 1. Given an auto with defective light, the student determines malfunction (fuse, bulb, or loose connection) and replaces bulb or fuse if necessary, or restores connection.

TO 1. Given an auto with defective light and hand tools, student removes and replaces bulb or fuse, without changing beam adjustment and restoring to normal operating condition.

TO 2. Given bulb to be replaced and a catalog, student identifies and secures equivalent replacement part.

TO 3. Given an auto with loose or corroded connection, student associates malfunction with corrective action and restores to normal operation.

Task 15. Replaces drive belts.

CO 1. Given an auto, student recognizes common drive belt defects such as excessive wear, tension, glazed or cracked belts.

TO 1. Given a variety of drive belts and belt defects, student recognizes characteristics which warrant replacement or adjustment.

CO 2. Given a defective drive belt, student removes and replaces with proper belt and adjusts to proper tension.

TO 1. Given a defective drive belt to be replaced, student locates replacement item in catalog, secures new belt and identifies method and procedure of installation from manual.

TO 2. Given a drive belt to be removed or adjusted, student uses required tools, belt adjusting gauge, belt adjusting tension specifications, and returns to operating condition.

Task 16. Replaces filters.

CO 1. Given an auto with filters, student determines need for replacing filter by observing the mileage, driving conditions, replacement intervals, or the condition of the fluid.

TO 1. Given an auto with filters (oil, air, gas), student identifies and associates suggested replacement standards with driving conditions, mileage or age of unit, condition of filter, or condition of oil.

CO 2. Given an auto requiring oil or fuel filter replacement, proper tools and refill item, student removes dirty filter and installs replacement unit leak tight.

TO 1. Given an auto requiring filter replacement, student identifies proper replacement item in catalog and method of installation from manual.

CO 3. Given an auto requiring air filter service, student determines appropriate service procedures and performs required service.

TO 1. Given an auto requiring air filter service, student identifies service manual standards and procedures, associates filter condition to service requirements, and restores to acceptable condition using specified cleaning agents.

Task 17. Receives credit and cash payments.

CO 1. Given a variety of services rendered, student computes total bill and performs cash or credit transactions without error.

TO 1. Given a customer bill to process, student identifies items, services at unit costs, computes total, and checks for error.
TO 2. Given a cash transaction to perform, student receives money and makes correct change without error.
TO 3. Given a credit transaction to perform, student records customer identification, items and costs on appropriate form(s) and distributes copies as required.

Task 18. Cleans service station area.

CO 1. Given a service station, student determines inside and outside periodic maintenance requirements and performs necessary cleanup operations.

TO 1. Given a service station requiring maintenance and cleanup, student identifies oil company manual and checklist, and performs tasks, according to company requirements and inspection criteria.
TO 2. Given a service station requiring maintenance and cleaning, student identifies tools, cleaning materials and agents, and restores to a functional and/or attractive condition.

Task 19. Keeps records and inventories.

CO 1. Given a sale, student itemizes amount and information of sale on register or daily sheet.

TO 1. (See Task 17, CO 1., TO 1.)
TO 2. Given a sale and items to record, student identifies proper forms and procedures and completes entries without error.

CO 2. Given a service station, student records fuel dispenser readings, lubricant dispenser readings, and fuel-storage tank stick readings on daily sheet.

TO 1. Given inventory information to record, student identifies proper measuring tools, instruments, and forms, and observes and records data accurately.

Task 20. Washes and polishes automobiles.

CO 1. Given an unclean automobile and customer's request, student washes and cleans interior and exterior, applies wax and cleans (wash or steam-clean) engine.

TO 1. Given an unclean automobile, and cleaning tools, materials, and agents, student removes foreign material, restoring to an attractive condition without damage to finish or fabric.

TO 2. Given a clean automobile to be waxed, student applies wax according to merchandise directions, restoring to an attractive and shiny condition.

TO 3. Given an engine to be cleaned, and steam cleaner, student identifies machine operating instructions, and performs operation according to required criteria without damage to auto.

Task 21. Services cooling system (minor).

CO 1. Given a radiator cap and a pressure tester, the student determines the serviceability of the radiator with the use of the pressure tester by comparing pressure reading with the pressure indicated on the cap.

TO 1. Given a radiator cap and a pressure tester, student identifies instructions and specifications for tester and cap, performs operation, obtains release pressure reading of cap, and rejects if defective.

CO 2. Given an automobile cooling system and pressure tester, the student tests for air-water tightness by applying specified pressure to system.

TO 1. Given an auto cooling system and pressure tester, student differentiates pressure requirements of caps and radiator-block system, and performs test on radiator, holding pressure for specified period of time.

CO 3. Given a defective cooling system, the student identifies the cause of the pressure drop such as leaky hose connection, punctured radiator, leaking gaskets, defect in engine water jacket, leaking heater core, etc., determines corrective action and performs minor repairs.

TO 1. Given a defective cooling system, student performs visual inspection, identifies malfunction and associates malfunction to required corrective repair.

TO 2. Given a cooling system with defective hose, student differentiates defective hose (such as very soft, brittle, or cracked) from manual standards by feeling with hand.

TO 3. Given a defective cooling system requiring new hose, student identifies replacement part(s), installs leak tight to return system to normal operation.

CO 4. Given an automobile cooling system and hand tools, the student drains, flushes, and refills cooling system with appropriate fluids.

TO 1. Given a cooling system requiring flushing, student locates all drain points, drains, flushes with fresh water observing condition of water at drain points.

TO 2. Given a clean cooling system, student secures drain points, identifies from chart the type and amount of coolant required, the proportion of water for correct mixture, and fills to proper level returning system to normal operation.

CO 5. Given an automotive cooling system and hand tools, student removes, tests, and replaces thermostat as required.

TO 1. Given a cooling system, student identifies thermostat replacement gasket, hand tools, removes thermostat for inspection and testing.

TO 2. Given a thermostat and thermostat tester, student identifies operating temperature of thermostat, tests, compares to specification, and rejects if defective.

TO 3. Given hand tools and a thermostat to be replaced, student prepares gasket surfaces and gaskets, inserts thermostat in proper position, and returns unit to leak-tight operation.

Task 22. Performs preventive and safety maintenance checks.

CO 1. Given an automobile, the student visually inspects for leaks, breaks, corrosion, loose parts, excessive wear, minor malfunctions, and performs minor maintenance and/or refers malfunction to service station mechanic or manager.

TO 1. Given an auto to be serviced, student identifies inspection chart by work area, and performs inspection while working, covering all appropriate items on checklist.

APPENDIX F

JOB DESCRIPTION -- SECOND LEVEL

POWER MECHANICS

Service Station Mechanic D.O.T. #620.381

A. Defining the Population

The majority of service station mechanics are employed in leased or independently owned service stations. Some automotive retail stores and garages also employ persons having duties similar to the service station mechanic. Some service station mechanics have had formal training during their public school years. Others gained employment as mechanics because of on-the-job training experience in local service stations and garages.

Excluded from this definition are:

1. Service station attendants who are primarily concerned with fueling, cleaning and lubricating motor vehicles and equipment.
2. Service station owners or managers who are primarily concerned with management procedures of a service station.
3. Garage mechanics who are primarily concerned with the internal and major repair of motor vehicle systems and components.

B. Statement of Mission

The primary mission of a service station mechanic is:

1. Performing minor repair and tuneup of motor vehicles.

Secondary missions are:

1. Servicing motor vehicles and automotive equipment (service station attendant tasks).
2. Supervising service station attendants and mechanic helpers.

The job duties for the service station mechanics vary from one employer to another. Usually, the mechanic is engaged in the removal, replacement, testing and adjustment of automotive components installed on a vehicle. He does not normally repair internal malfunctions of the engine, transmission, and differential. He may service vehicles and sell automotive products. The mechanic performs his duties inside the station or, in the case of emergency calls, outside at the inoperative vehicle.

C. Function and Components of Function

Things	Data	People
Handling	Computing	Taking Instructions
Manipulating	Analyzing	Exchanging Information
Operating-Controlling		

The things the service station mechanic handles and manipulates are hand and power tools and automotive parts. He operates and controls various equipment such as wheel balancers and electrical testers. The mechanic is concerned with data functions of computing costs and analyzing test results. His involvement with people is in taking instructions from a station owner or manager and receiving and conveying information from and to customers.

D. Segments

The main steps involved in the occupation of a service station mechanic are receiving information, determining malfunctions, analyzing data, adjusting components, repairing vehicles and computing charges.

E. Contingencies and Contexts

1. May have to keep records and inventories.
2. May have to order materials and supplies.
3. May have to service vehicles and perform attendant duties.
4. May have to perform major repairs of vehicles.

F. Task Classification

a. Basic Tasks

1. Perform minor engine tuneups.
2. Check or inspect wheel bearings.
3. Inspect exhaust systems.
4. Service and adjust brake systems.
5. Lubricate universal joints.
6. Replace windshield wiper blades.
7. Remove, install, and adjust carburetors.
8. Perform operational brake inspections.
9. Lubricate front wheel bearings.
10. Perform operational engine inspections.
11. Remove and install starters.
12. Replace brake shoes.
13. Replace flasher units.
14. Install gaskets and seals.
15. Replace exhaust system components.
16. Replace fuel pumps.
17. Remove and install generators or alternators.
18. Perform operational checks of windshield wiper systems.
19. Perform operational inspections of propeller shafts, u-joints, and center bearings.

20. Remove and install radiators.
21. Adjust or replace emergency brake controls.
22. Repair or replace master cylinders.
23. Remove, install, and adjust distributors.
24. Repair or replace master or wheel cylinders.
25. Replace shock absorbers.
26. Repair or replace switches.
27. Perform operational inspections on manual transmissions.
28. Adjust, repair, or replace backup light switches.
29. Perform operational inspections of electrical systems.
30. Replace thermostats.
31. Replace fuel filters.
32. Inspect seat belts.
33. Perform inspections of vehicle condition.
34. Perform operational inspections of fuel systems.
35. Check or replace exhaust manifolds.
36. Replace brake hoses and lines.
37. Perform visual inspections of suspension systems.
38. Repair or replace windshield wiper units.
39. Inspect vehicles for compliance with local laws.
40. Perform operational inspections of positive crankcase ventilation systems.
41. Repair or replace instruments and sending units.
42. Install seat belts.
43. Repair distributors.
44. Repair or replace relays.
45. Maintain service station lifts and lubrication equipment.
46. Replace heater water control units.
47. Balance wheels and tires.
48. Maintain tire removal equipment.
49. Inspect or resurface brake drums.
50. Initiate and complete work orders.
51. Service or replace manifold heat controls.
52. Control flow of work.
53. Initiate requests for parts.
54. Replace grease boots.
55. Repair or replace hydraulic lines and fittings.
56. Service or replace heater components.
57. Retrieve disabled vehicles.
58. Perform operational inspections of exhaust emission control systems.
59. Install emergency warning devices.
60. Maintain washrack equipment.
61. Repair or fabricate hydraulic hoses.
62. Perform operational automatic transmission inspections.
63. Review procured parts for installation on proper vehicles.
64. Repair or maintain power lawn mowers.
65. Repair locks and latches.
66. Determine actual cost of vehicle repairs.

67. Inspect, fabricate, or repair hydraulic lines.
68. Repair or replace rectifiers.
69. Test or repair radiator core leaks.
70. Perform operational inspections of air conditioning systems.

b. Advanced Tasks

1. Repair or service carburetors.
2. Analyze causes of vehicle failures.
3. Repair starters.
4. Analyze or adjust engine performance using engine analyzer.
5. Repair generators or alternators.
6. Repair air brake systems.
7. Repair or replace hydraulic power brake units.
8. Repair or replace electrical motors.
9. Repair or replace power steering pumps.
10. Repair or service air-conditioning systems.
11. Install air-conditioners in vehicles.

c. Specialty Tasks

1. Radiator repair.
2. Transmission repair.
3. Front end alignment.

d. Ancillary Tasks

1. Cleaning various components and parts.
2. Removal and replacement of components to gain access to other components.

e. Redundant Tasks

1. Removal and replacement of nuts, bolts, and screws.
2. Turning of tester handles and knobs.
3. Using small handtools and power tools.

APPENDIX G

SAMPLE PERFORMANCE EVALUATION

7/69

Power Mechanics DOT #915.867

PERFORMANCE EVALUATION

PE # 9-5

CHARGING BATTERIES

OBJECTIVE: 1) Correctly connect a battery to either a slow or a fast charger. 2) Charge at the proper rate for the required amount of time. 3) Perform certain tests and checks on batteries.

OVERVIEW: There are two methods of charging--slow charge and fast charge. Always slow charge if possible. Fast charging is harder on the battery. It could, if done too often, harm the battery. For example, sulfated batteries have a high resistance. They will cause an excessive voltage rise while fast charging. Charging too fast may also cause gassing. This is caused by rapid decomposition of the electrolyte into hydrogen and oxygen gas. This will wash active materials from the plates causing permanent damage. Maintaining too high a charging rate may also cause excessive temperature rise. This could bulge the case and sealer. It could also accelerate positive plate corrosion. Loss of electrolyte is typical in all three examples.

Obviously, the attendant and mechanic must exercise some care when charging the battery, especially when fast charging. Furthermore, there are a few simple tests you should always perform before charging.

EQUIPMENT: Fender cover, hydrometer, distilled water dispenser, training batteries, fast charger, and slow charger. (Also Tote-Tray #9-1 if you are working on a customer's car.)

PREREQUISITES:
- ☐ Learning Unit #9-5 or
- ☐ Chek-Chart's Car Service, Chek-Chart Corporation, pp. 6-7 or
- ☐ Instructor's Options

OPTIONAL READING:
- ☐ Automotive Mechanics, by Crouse, 5th ed. p. 362.

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Instructions:

(1) Fill in name and date on the last two pages. When you have completed the performance evaluation, you will get one copy, the instructor will file the other.

(2) Do the training check questions below and give answer card to instructor.

(3) Complete the performance evaluation under instructor's supervision. He must see proof of your performance.

TRAINING CHECKS: T-T No. Z-11. The correct answer is **H**.
Start with number **13**.

13. Battery capacity usually refers to

    a. battery voltage.
    b. battery efficiency.
    c. the amount of electrolyte.
    d. electrical size or capability.

14. The 12-volt and 6-volt battery are different in that the 12-volt battery has

    a. 12 cells and 12 vent caps.
    b. 24 cells and 24 vent caps.
    c. 3 cells and 3 vent caps.
    d. 6 cells and 6 vent caps.

15. Fast charging may take from

    a. 15 to 40 minutes.
    b. 1 to 2 hours.
    c. 12 to 36 hours.
    d. 4 to 5 days.

16. The fast charge rate for a 12-volt battery should be about

    a. 5 to 15 amps.
    b. 100 to 120 amps.
    c. 180 to 360 amps.
    d. 50 to 60 amps.

17. The battery may be considered charged when the specific gravity reaches

    a. 1.100
    b. 1.150
    c. 1.265
    d. 1.300

18. The hydrometer reading for a serviceable battery should be be about

    a. 1.265
    b. 1.175
    c. 1.150
    d. 1.100

19. Before connecting charger to battery

    a. do battery charger tests.
    b. disconnect battery ground cable.
    c. turn charger on.
    d. disconnect + cable.

20. The slow charge rate for a 12-volt battery should be about

    a. 120 to 240 amps.
    b. 240 to 440 amps.
    c. 1 to 10 amps.
    d. 50 to 60 amps.

21. Slow charging may take from

    a. 4 to 5 days.
    b. 12 to 36 hours.
    c. 6 to 12 minutes.
    d. 15 to 40 minutes.

22. When connecting the charger leads to the battery terminals, connect

    a. - lead to + terminal and + lead to ground.
    b. + lead to - terminal and - lead to ground.
    c. + lead to - terminal and - lead to + terminal.
    d. + lead to + terminal and - lead to - terminal.

23. A sulfated battery should be

    a. at a very fast and high rate.
    b. reversed charged.
    c. slow charged.
    d. fast charged.

PART A: SLOW CHARGING

(One to Ten Amp Charging Rate.)

UNIT OBJECTIVE 1: Prepare battery for slow charging.

NOTE: Your instructor will probably assign a training battery to you for this test.

A. Does the battery have a "bad" cell? ____________

#24. How many points can the cells vary before being considered "bad" or dead?

a. 25 points
b. 2.5 points
c. .25 points
d. 250 points

B. Is the battery in a state of discharge? ____________

C. What is your average or typical reading? ____________

D. What type of battery are you testing? ____________ volts.

#25. What is the proper charging rate for the slow charge?

a. 40 to 50 amps.
b. 1 to 10 amps.
c. 20 to 30 amps.
d. 100 to 140 amps.

#26. What is the color of the positive (+) lead?

a. red
b. green

STOP ________________
initials

INSTRUCTOR CHECK #1:
DO NOT turn charger ON until job is checked by instructor.

UNIT OBJECTIVE 2: Correctly operate slow charger, making periodic checks and adjustments.

#27. How often is a hydrometer reading necessary when first starting the charge?

a. Every 10 to 20 minutes
b. Every 30 to 40 minutes
c. Every day
d. Every 2 or 3 hours

A. Three factors determine when slow charge should be stopped.

#28. In what way can hourly hydrometer readings determine when to stop slow charging?

a. It tells the state of charge of the battery.
b. No change in reading over a period of 2 or 3 hours.
c. When the time exceeds limit on charge.
d. All batteries require same amount of time to charge.

#29. Gassing may show when slow charge should be stopped. For example:

a. When a good bit of gassing occurs, battery has reached its capacity.
b. When gassing occurs, electrolyte is getting weak.
c. A good battery will never give off gas.
d. Gas indicates battery is not charging.

#30. Why may excessive heat be a reason to stop charging?

a. A battery works better when it is hot.
b. Excessive heat will not hurt a battery.
c. Heat has no connection to charging batteries.
d. When battery has reached its capacity it gets hot.

B. Complete job.

STOP ____________________ INSTRUCTOR CHECK #2
initials

PART B: FAST CHARGING

(For 12-Volt Batteries--50 to 60 Amps for 15 to 30 Minutes.)

UNIT OBJECTIVE 3: Prepare a battery for fast charging.

A. Use fender cover if working on a customer's car. (The instructor may ask you to work on a shop battery.)

B. Does the battery have a dead cell? ____________

Is it discharged? ____________ What is the average or typical hydrometer reading? ____________

#31. A battery may be fast charged when

- a. it is more than 50% discharged.
- b. it is less than 50% discharged.
- c. it is dead.
- d. it makes no difference.

What is the battery voltage type? ____________

STOP ________________
initials

INSTRUCTOR CHECK #3:
Make certain student has read and understands charger directions. Check the connections and machine. The student should explain what he would do if the fan were running with the pilot light out.

UNIT OBJECTIVE 4: Correctly perform battery tests following charger instructions.

A. What is the proper voltage range? ____________

Are both the pilot light and fan ON? ____________

If the fan is ON and the pilot light OUT, get the instructor.

B. Follow exactly the "OPERATING INSTRUCTIONS TO TEST BATTERY".

Which zone does the pointer move into? Red / Yellow / Green

If there are any problems, call instructor.

What is the indicated charging time? ____________

#32. What would be required if the indicated time exceeded 40 minutes?

a. Remove electrolyte from battery and fill with new.

b. Get instructor, battery may require a voltage meter test for each cell.

c. Install new battery.

d. Double the charging time.

UNIT OBJECTIVE 5: Charge battery following battery charger instructions accurately.

A. Follow exactly the "OPERATING INSTRUCTIONS TO CHARGE BATTERIES", and do the job.

#33. How often should you check for gassing?

a. Only at first.

b. Only at the end.

c. Every 30 minutes.

d. Frequently

B. List some safety precautions for working around batteries which are being charged:

____

____

____

#34. The temperature should not be allowed to rise above

a. 120°F.

b. 180°F.

c. 220°F.

d. 90°F.

C. Does the meter pointer advance normally while battery is being charged? ____________

Is the meter pointer near the left side of the green zone?

____

#35. If battery gives meter readings near the left side of the green zone, the battery is

a. good.
b. undercharged.
c. defective.
d. overcharged.

Is the meter in the red zone? ____________

#36. Red zone meter reading is caused by a cold, sulfated, or

a. good battery.
b. defective battery.
c. too high a charging rate.
d. too low a charging rate.

#37. BEFORE removing charger leads from battery you must

a. install battery caps.
b. check battery.
c. start car.
d. turn charger off.

STOP ________________ INSTRUCTOR CHECK #4
initials

UNIT OBJECTIVE 6: Identify defective batteries by following battery charger test procedures.

A. Move charger to the bench of training batteries.

B. Set up charger using proper procedures and safety rules.

C. Identify the following defective batteries.

#38. Which battery is less than 50% charged and in need of a slow charge?

a. Battery "A"
b. Battery "B"
c. Battery "C"
d. Battery "D"

#39. Which battery gives an indication of being sulfated or worn out?

a. Battery "D"
b. Battery "C"
c. Battery "B"
d. Battery "A"

#40. Which battery is defective, as indicated by a meter pointer remaining near the left side of the green zone?

a. Battery "A"
b. Battery "B"
c. Battery "C"
d. Battery "D"

STOP ________________ INSTRUCTOR CHECK #5
initials

PE 9-5/7-69

QPS/AIR/ABLE
Power Mechanics
DOT #915.867
Unit PE #9-5

____
Student

____________ ____________
Date Instructor

CHARGING BATTERIES

L M S
☐☐☐ Charges batteries with fast and slow charges.

Instructor Checks:

1. Correctly answers 80% (8) of the training check questions.	U	S
2. Prepares battery for slow charging.		
a. Performs visual inspection and hydrometer tests.	U	S
b. Safely disconnects and removes battery from vehicle.	U	S
c. Cleans battery and frame.	U	S
d. Selects proper voltage.	U	S
e. Connects - lead to - post and + lead to + post, with charger OFF.	U	S
f. Reads and follows charger instructions accurately.	U	S
3. Correctly operates slow charger making periodic checks and adjustments.		
a. Takes hydrometer and temperature readings at proper intervals.	U	S
b. Prevents excessive gassing or temperature readings above 120°F.	U	S
c. Stops charging when specific gravity readings stabilize and electrolyte gasses freely.	U	S
d. Turns charger OFF before removing leads.	U	S
e. Adds water as required and cleans top of battery.	U	S
f. Follows correct procedures in replacing battery.	U	S

(Continued)

4.	Prepares a battery for fast charging.		
	a. Performs visual checks, hydrometer tests, and adjusts water as required.	U	S
	b. Cleans battery and removes ground lead.	U	S
	c. Properly connects leads with charger OFF.	U	S
	d. Selects proper voltage.	U	S
	e. Reads and follows charger instructions accurately.	U	S
5.	Correctly performs battery tests following charger instructions.		
	a. Checks pilot light and fan, referring problems to instructor or mechanic.	U	S
	b. Checks meter indication and refers any problems to instructor or mechanic.	U	S
	c. Determines charging time.	U	S
6.	Charges battery following battery charger instructions.		
	a. Checks frequently for excessive gassing and high temperature--makes adjustments accordingly.	U	S
	b. Detects meter indications at left side of green zone and readings too far into the red zone. Refers any such problems to instructor or mechanic.	U	S
	c. Turns charger OFF before removing leads.	U	S
7.	Identifies defective batteries by following battery charger test procedures.		
	a. Batteries less than 50% charged (in need of slow charging).	U	S
	b. Sulfated or worn-out batteries.	U	S
	c. Batteries which give meter readings near the left side of the green zone.	U	S
8.	Performs tasks in an appropriate amount of time.	U	S

PE 9-5/7-69

QPS/AIR/ABLE
Power Mechanics
DOT #915.867
Unit PE #9-5

Student: ____________________

Date: __________ Instructor: __________

CHARGING BATTERIES

L M S
☐☐☐ Charges batteries with fast and slow charges.

Instructor Checks:

1. Correctly answers 80% (8) of the training check questions.	U	S
2. Prepares battery for slow charging.		
a. Performs visual inspection and hydrometer tests.	U	S
b. Safely disconnects and removes battery from vehicle.	U	S
c. Cleans battery and frame.	U	S
d. Selects proper voltage.	U	S
e. Connects - lead to - post and + lead to + post, with charger OFF.	U	S
f. Reads and follows charger instructions accurately.	U	S
3. Correctly operates slow charger making periodic checks and adjustments.		
a. Takes hydrometer and temperature readings at proper intervals.	U	S
b. Prevents excessive gassing or temperature readings above 120°F.	U	S
c. Stops charging when specific gravity readings stabilize and electrolyte gasses freely.	U	S
d. Turns charger OFF before removing leads.	U	S
e. Adds water as required and cleans top of battery.	U	S
f. Follows correct procedures in replacing battery.	U	S

(Continued)

4. Prepares a battery for fast charging.

a. Performs visual checks, hydrometer tests, and adjusts water as required.	U	S
b. Cleans battery and removes ground lead.	U	S
c. Properly connects leads with charger OFF.	U	S
d. Selects proper voltage.	U	S
e. Reads and follows charger instructions accurately.	U	S

5. Correctly performs battery tests following charger instructions.

a. Checks pilot light and fan, referring problems to instructor or mechanic.	U	S
b. Checks meter indication and refers any problems to instructor or mechanic.	U	S
c. Determines charging time.	U	S

6. Charges battery following battery charger instructions.

a. Checks frequently for excessive gassing and high temperature--makes adjustments accordingly.	U	S
b. Detects meter indications at left side of green zone and readings too far into the red zone. Refers any such problems to instructor or mechanic.	U	S
c. Turns charger OFF before removing leads.	U	S

7. Identifies defective batteries by following battery charger test procedures.

a. Batteries less than 50% charged (in need of slow charging).	U	S
b. Sulfated or worn-out batteries.	U	S
c. Batteries which give meter readings near the left side of the green zone.	U	S

8. Performs tasks in an appropriate amount of time.	U	S

APPENDIX H

SAMPLE LEARNING UNIT

DOT #915.867 UNIT # 7-1

POWER MECHANICS

CLEAN, GAP, AND TEST SPARK PLUGS

EDUCATIONAL SYSTEM FOR THE SEVENTIES
ES '70
A COOPERATIVE PROGRAM FOR EDUCATIONAL INNOVATION

JULY 1969

Prepared by:

Quincy Public Schools
Coddington Street, Quincy, Massachusetts 02169

American Institutes for Research
135 North Bellefield Avenue, Pittsburgh, Pennsylvania 15213

as part of Project ABLE under Contract No. OE-5-85-019
with the Bureau of Research, Office of Education,
U. S. Department of Health, Education, and Welfare.

Name

Date

Hr Min

Power Mechanics 915.867
Learning Unit #7-1
(2hrs. 20min.) 7-69

CLEAN, GAP, AND TEST SPARK PLUGS

OBJECTIVE: When you have completed this unit, you will be able to clean and test spark plugs using abrasive blast equipment. You will be able to gap plugs properly with both the wire gage and plug gapper tool.

OVERVIEW: The only "sure" way to test spark plugs is under actual firing conditions with an engine analyzer and scope. Furthermore, spark plug work is fast becoming a disposable replacement item. The reason is simple--the cost of removing, cleaning and then replacing a used plug is no longer economical. High performance engines require top performance from plugs and labor costs make the servicing of such items a marginal profit activity. Important, also, is the fact that just a small amount of the cleaning abrasive left in the plug can cause excessive engine wear. While fewer plugs are being cleaned, you will be asked, from time to time, to do this task.

EQUIPMENT: Tote-Tray #7-1 with spark plug file, solvent, wire gage, gapping tool, wire brush, and specification chart. Get box #7-3 with sample plugs for cleaning and testing.

T-T No. Z-11: The correct answer is **L**. Start with question **1**.

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UNIT OBJECTIVE 1: Clean spark plugs.

Step **1.** View 8mm film, "Spark Plug Service".

2. Prepare plug for cleaning: Wipe outside of plug with solvent. Wash any oil-fouled plugs in solvent and then air dry. This will prevent fouling the abrasive in cleaning machine.

3. Select the proper adapter (14mm or 18mm).

#1. Does a 14mm plug have a smaller or larger thread diameter than an 18mm?

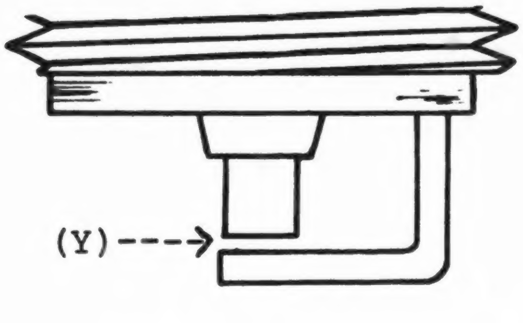
  c. 14mm is larger.

  d. 14mm is smaller.

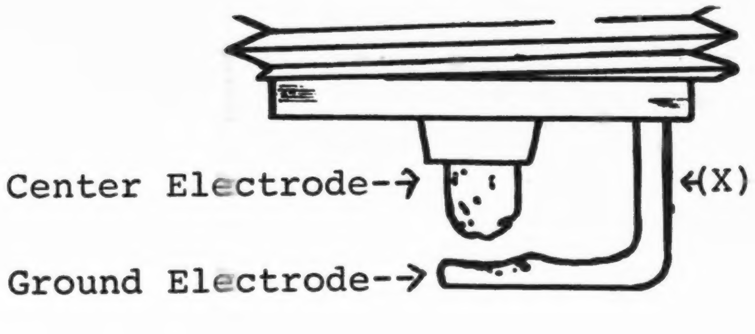
4. Clean plug in machine. CAUTION: Use goggles. Abrasive blast each plug for 3 to 6 seconds while slowly rotating plug. Repeat if necessary. (If not clean on second blast, machine may need new abrasive.) Compare to new plug.

5. Now use a straight air blast to remove any abrasive from inside the plug.

6. Remove plug from adapter and clean plug threads with a wire brush. DO NOT touch electrodes or insulator with wire brush.

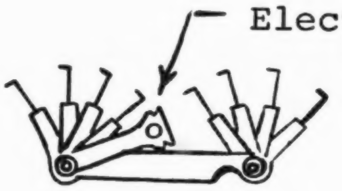


NEW PLUG ELECTRODES



NORMAL ELECTRODE WEAR

7. Bend ground electrode at point "(X)" to insert file between ground and center electrode at point "(Y)".



Electrode adjusting tool on wire gage set.

8. File carefully to remove lead deposits and to square end of center electrode. This is a delicate job. A center electrode with a sharp square end gives better sparking action.

9. Air blast and then dip in clean solvent to remove any abrasive. Abrasive grit (practically invisible to the eye) remaining after the cleaning operation, could cause excessive engine wear.

10. Practice cleaning two or three plugs.

STOP ____________ initials

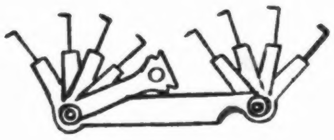
INSTRUCTOR CHECK #1:
Check student on use of machine. Check on method of bending electrode and use of file. Demonstrate use of wire gage and gapping tool.

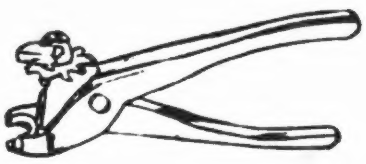
UNIT OBJECTIVE 2: Adjust spark gap to specification.

Step 1. Check the spec chart for proper spark plug gap for the vehicle you are working on. (If you are using sample plugs, check the number on the plug. Then find a car in the chart that uses that plug.)

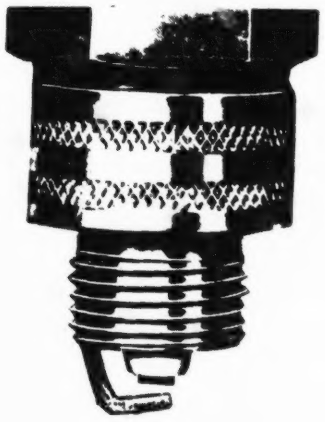
________ year ________ vehicle ________ plug and no. ________ gap

2. Adjust a plug with the plug gapping tool. Use the gapper tool whenever possible.

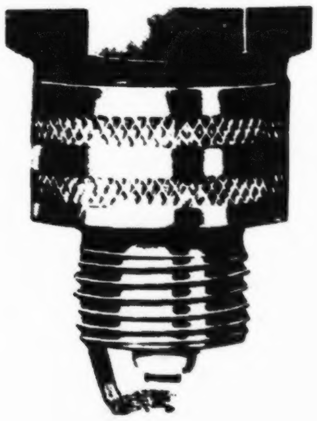




3. Now adjust another plug but use the wire gage. The wire gage works well on used plugs. You must bend the side (ground) electrode when making adjustments.



wrong



right

Test with the proper size wire.
Gap is correct when wire binds slightly. (New plugs must always be gapped to proper specs.)
NOTE: The instructor will check your two plugs when you have completed the unit. Practice until you are accurate.

UNIT OBJECTIVE 3: Test plugs under high pressure and voltage.

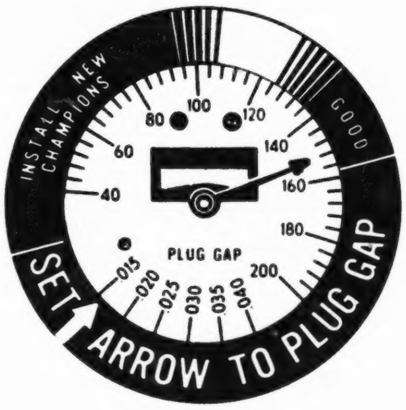
Step 1. Get the four plugs marked A, B, C, and D.

2. Gap each to .035 with gapping tool (for this particular test).

3. Using proper adapter for plug, screw plug into adapter and attach spark plug wire.

This machine uses compressed air in a pressure chamber and high voltage to test sparking ability. There are many plug defects this test will not show. However, there are times when it is convenient to use this device.

4. Set ARROW to plug gap (in this case, .035).


INSTALL NEW CHAMPIONS
GOOD
40
60
80
100
120
140
160
180
200
PLUG GAP
.015
.020
.025
.030
.035
.040
SET ARROW TO PLUG GAP

5. Holding button down to right of machine, note spark in mirror below plug.

6. Apply air pressure by turning knurled knob counter-clockwise ↶. Watch spark in mirror until it goes out. Now check to see how much air pressure you have. Note the color codings.

7. Test the 4 plugs in Tote-Tray #7-1 and answer the questions below.

#2. Plug "A" is
    c. good.
    d. bad.
#3. Plug "B" is
    c. good.
    d. bad.
#4. Plug "C" is
    c. good.
    d. bad.
#5. Plug "D" is
    a. good.
    b. bad.

8. Plugs which are to be replaced in a vehicle should have new gaskets. (Exception--plugs with tapered seat.)

STOP __________________ INSTRUCTOR CHECK #2:
initials Check plugs gapped by student. Check the test plugs--STEP 4.

OPTIONAL READING: Auto Mechanics Fundamentals by Stockel, Chapter 3, pp. 9-12.

SUMMARY: You must use care when operating the cleaning machine--sand could be blasted into your eyes. The same abrasive grit could ruin the engine if allowed to remain in the plug. Many mechanics make the mistake of using a flat gage to gap spark plugs--use the gapping tool or wire gage. Plugs are often cleaned and adjusted about every 5,000 to 6,000 miles. However, many mechanics recommend using the plugs a few extra miles and then replacing with new plugs.

UNIT EVALUATION

Clean, Gap, and Test Spark Plugs

Test Questions: T-T No. Z-11. The correct answer is **L**.

6. Before cleaning plug in the abrasion-blast machine, check for

   a. electrode gap setting.
   b. oil fouling.
   c. plug performance.
   d. high voltage.

7. When cleaning spark plugs in machine with sand blasts, the spark plug should be

   a. rotated slowly.
   b. held loosely.
   c. raised and lowered often.
   d. held firmly without moving.

8. The spark plug should be filed to

   a. prevent fouling.
   b. re-gap new plugs.
   c. remove oil deposits.
   d. remove deposits and square electrodes.

9. A used spark plug should be gapped by

   a. using flat feeler gage.
   b. bending ground electrode.
   c. bending center electrode.
   d. using spark plug tester.

10. To test spark plug in tester, you must

    a. push the abrasive button.
    b. rotate plug with short blasts.
    c. apply voltage and air pressure.
    d. hold wire firmly with hand.

11. After cleaning plugs with abrasive

    a. dip in oil.
    b. gap, test and replace.
    c. tap electrode against bench to remove abrasive.
    d. remove abrasive with air or solvent.

(Continued)

12. Before replacing used cleaned plugs in a vehicle

    a. install new gaskets (excepting tapered seats).
    b. tap electrode against bench to remove abrasive.
    c. lubricate well with oil.
    d. clean plugs in degreasing tank.

Instructor Checks:

1. Correctly answers 80% (6) of the test questions. U | S
2. Cleans spark plugs to a new-like condition.
   a. Washes any oil-fouled plugs in solvent to prevent contamination of abrasive. U | S
   b. Cleans plug in proper adapter with three to six second blasts while rotating plug. U | S
   c. Removes abrasive grit with blasts of clean air. U | S
   d. Adjusts ground electrode by bending side electrode with tool in proper position. U | S
   e. Uses file to correctly square end of center electrode. U | S
3. Adjusts spark gap to specifications.
   a. Identifies correct gap specification. U | S
   b. Uses gapper tool and wire gage to adjust gap properly and accurately. (Wire gage should bind slightly.) U | S
4. Tests plugs under high pressure and voltage.
   a. Sets adjustments and uses equipment correctly. U | S
   b. Tests and identifies defective plugs. U | S
5. Performs unit in an appropriate amount of time. U | S

APPENDIX I

STUDENT AND TEACHER REACTION FORMS

Academic Area: ___ English ___ Math ___ Social Studies ___ Science
Vocational Area: ___ General Woodworking ___ Electronics ___ Power Mechanics

Learning Unit: ______________________________ Date started ____________________
Date finished ____________________

STUDENT

PROJECT ABLE REACTION FORM

1. This unit was

interesting ____Yes ____No
easy ____Yes ____No
enjoyable ____Yes ____No
useful ____Yes ____No
new material ____Yes ____No

2. In this learning unit, I had problems

_____understanding the content, readings
_____understanding the vocabulary
_____following directions
_____performing the jobs or activities in the unit
_____understanding problems, charts, graphs
_____getting supplies or equipment
_____using the audio-visuals
_____using the training aids
_____with too much theory
_____with the length of the unit
_____working on my own
_____working with others
_____passing the evaluation

3. Did you go to the teacher for help on this learning unit? ____Yes ____No

If Yes, Why?

4. Did you go to a classmate for help on this learning unit? ____Yes ____No

If Yes, Why?

5. Write any other comments you have about this unit (how you would change or improve it, what you liked or disliked the most, etc.).

Academic Area: ___ English ___ Math ___ Social Studies ___ Science
Vocational Area: ___ General Woodworking ___ Electronics ___ Power Mechanics

Learning Unit: ______________________________

TEACHER

PROJECT ABLE REACTION FORM

1. With what aspects of the learning unit were the students successful?

2. List the problems your students had with this unit.

3. In your opinion, was the unit successful in accomplishing its objectives?

   ____Yes ____No Explain:

4. List suggestions for revisions of the unit, if any.

______________________ Teacher's Name

______________________ Date Completed

APPENDIX J

SAMPLE OCCUPATIONAL READINESS RECORD

OCCUPATIONAL READINESS RECORD

To The Employer:

This occupational readiness record is both an inventory of the training course content and level of proficiency or achievement demonstrated by the graduate. Graduates can provide potential employers with more complete performance check lists which itemize in great detail the skills and knowledge in which he has demonstrated proficiency. It is recognized that persons working at the specified occupational level will function with direction and assistance from superiors. As a part of his training, the graduate has learned to expect appropriate instructions with each assigned task. Furthermore, the graduate should understand that he lacks the authority and training to perform certain functions and operations. He will expect and seek, supervision, assistance and direction where appropriate. Note that the job tasks as identified, are basic to the next higher or more sophisticated job level. Work experience and further training may qualify the graduate for more complicated tasks, a new job title, and higher pay.

Key To Proficiency Code:

Level L: Limited Skill--does simple parts of task using required tools, but requires instruction and supervision to do most parts of the job. Identifies parts by name, knows simple facts about the job.

Level M: Moderate Skill--requires help on some parts, but can use most tools and special equipment needed. Knows work procedures but may not meet minimum demands for speed or accuracy.

Level S: Skilled--understands operating principles and accomplishes all parts of task with only spot checks of finished work. Meets minimum demands for speed and accuracy.

All graduates receiving this document have satisfactorily demonstrated to the training staff their ability to work safely, understand and carry out instructions, and cooperate with other employees. This document also attests to their punctuality, reliability, and general work habits.

Project ABLE
Quincy Public Schools
American Institutes for Research

JOB FAMILY: Auto Mechanics and Related Occupations
EXIT LEVEL: Service Station Attendant (915.867) and Related Occupations

Name________________________ Date________________

Soc. Sec. No.________________ Length of Training________

Certified by_________________ Title_______________

Comments____

L M S

☐☐☐ Shop Safety

☐☐☐ Fire Safety

☐☐☐ Basic Mechanic's Handtools

☐☐☐ Automotive Hardware

☐☐☐ Automotive Terminology

☐☐☐ Identifies Customer Needs

☐☐☐ Cleans Service Area and Equipment

☐☐☐ Raises Cars With Floor Jacks and Combination Bumper-Frame Jacks

☐☐☐ Raises Cars With Twin-Post Hydraulic Lift

☐☐☐ Identifies and Replaces Defective Drive Belts

☐☐☐ Inspects Vehicle Lighting Circuit

L M S

☐☐☐ Services Miniature Bulbs and Sockets

☐☐☐ Removes and Replaces Headlamps

☐☐☐ Identifies Common Spark Plug Deposits

☐☐☐ Cleans, Gaps and Tests Spark Plugs

☐☐☐ Removes and Replaces Spark Plugs

☐☐☐ Tests and Adjusts Tire Pressure

☐☐☐ Removes and Rotates Wheels

☐☐☐ Inspects Tires and Identifies Common Defects and Wear

☐☐☐ Mounts and Demounts Tubeless and Tube-Type Tires on Tire Machine

☐☐☐ Repairs Tubeless and Tube-Type Tires

L	M	S	
☐	☐	☐	Washes and Polishes Vehicles
☐	☐	☐	Tests Battery With Battery Hydrometer
☐	☐	☐	Inspects Batteries and Performs Minor Repairs
☐	☐	☐	Cleans Batteries, Posts and Cables
☐	☐	☐	Removes and Replaces Batteries
☐	☐	☐	Charges Batteries With Fast and Slow Charger
☐	☐	☐	Inspects and Tests Radiator Pressure Caps
☐	☐	☐	Pressure Tests Cooling Systems
☐	☐	☐	Tests Antifreeze
☐	☐	☐	Identifies Common Hose Defects
☐	☐	☐	Removes and Replaces Hoses

L	M	S	
☐	☐	☐	Visually Inspects Cooling System Identifies Common Defects and Leak Points
☐	☐	☐	Flushes and Fills Cooling Systems
☐	☐	☐	Tests Thermostats
☐	☐	☐	Removes and Replaces Thermostats
☐	☐	☐	Lubricates Body--Doors, Hinges, etc.
☐	☐	☐	Identifies Specified Engine Oil, ATF and Lube Grease
☐	☐	☐	Checks Engine Oil and ATF and Fills to Proper Level
☐	☐	☐	Determines Oil Lubrication and Filter Service Requirements
☐	☐	☐	Services Air and Gas Filters
☐	☐	☐	Changes Oil and Oil Filter
☐	☐	☐	Lubricates Chassis

The trainee has had limited experience in dispensing fuel, receiving credit and cash payments, and keeping records and inventory. On-the-job training required in these and other areas.

APPENDIX K

ORGANIZED ACTIVITIES: FIRST LEVEL

STUDENT: ____________________

FAMILY: Power Mechanics
AREA: Auto Mechanics and Related Occupations
EXIT LEVEL: Service Station Attendant (915.867) and Related Occupations

ACTIVITIES*

LEARNING UNIT OR PREREQUISITE ACTIVITY	PERFORMANCE EVALUATION		
☐	○	1-1	Shop Safety
☐	○	1-2	Fire Safety
☐	○	1-3	Mechanic's Handtools
☐	○	1-4	Automotive Hardware
☐	○	1-5	Automotive Terminology
☐	○	2-1	Customer Service and Sales
☐	○	3-1	Jacks and Lifts

*See Performance Check Lists for each unit for a more detailed explanation of job standards and shop activity.

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☐ ○ 4-1 Wash and Polish

☐ ○ 5-1 Drive Belts

☐ ○ 6-1 Miniature Bulbs
☐ ○ 6-2 Headlamps

☐ ○ 7-1 Clean Gap and Test Spark Plugs
☐ ○ 7-2 Changing Spark Plugs

☐ ○ 8-1 Tire Inflation
☐ ○ 8-2 Remove and Rotate Wheels
☐ ○ 8-3 Inspect Tires
☐ ○ 8-4 Tire Mounting Machine
☐ ○ 8-5 Repair Tires and Tubes

☐ ○ 9-1 Battery Hydrometer
☐ ○ 9-2 Inspect Batteries
☐ ○ 9-3 Clean Batteries
☐ ○ 9-4 Remove and Replace Batteries
☐ ○ 9-5 Charging Batteries

(Continued)

☐	○	10-1	Radiator Pressure Caps
☐	○	10-2	Pressure Testing Cooling Systems
☐	○	10-3	Testing Antifreeze
☐	○	10-4	Cooling System Hoses
☐	○	10-5	Visual Inspection of Cooling System
☐	○	10-6	Flushing and Filling Cooling System
☐	○	10-7	Testing Thermostats
☐	○	10-8	Remove and Replace Thermostats

☐	○	11-1	Lubrication Service
☐	○	11-2	Body Lubrication
☐	○	11-3	Engine Oil and ATF
☐	○	11-4	Air and Gas Filters
☐	○	11-5	Oil and Filter Change
☐	○	11-6	Chassis Lubrication

APPENDIX L

TIME REQUIREMENTS BY UNIT

MEDIAN TIME PER UNIT IN MINUTES

Unit Number	Learning Unit	Performance Evaluation
1-1	160	50
2-1	140	60
3-1	100	60
4-1	90	90
5-1	77	33
6-1	90	60
6-2	60	45
7-1	150	60
7-2	87	100
8-1	60	45
8-2	60	120
8-3	50	50
8-4	110	60
8-5	75	75
9-1	55	70
9-2	56	38
9-3	60	60
9-4	75	45
9-5	180	150
10-1	90	45
10-2	50	53
10-3	75	30
10-4	95	60
10-5	75	60
10-6	90	90
10-7	110	105
10-8	90	87
11-1	30	35
11-2	90	95
11-3	90	86
11-4	120	106
11-5	120	115
11-6	150	148

Performance Evaluations--39 hours; Learning Units--48 hours.

The average student would require eight to nine weeks to complete the first level training program*. Practical experience has found this time to average between nine and ten weeks. Some students will complete the requirements in a matter of a few weeks. Others may take an entire semester.

*Computed on the basis of a shop class composed of three continuous 55 minute periods allowing 35 minutes for preparation, clean-up, etc.

APPENDIX M

MOCK-UPS, TRAINING AIDS AND EQUIPMENT: FIRST LEVEL

POWER MECHANICS

Mock-Ups, Training Aids and Equipment

ENGINES:

1. 6 cylinder flathead (e.g. old Chrysler, Plymouth '59 or older, Ford '51 or older. The Chrysler product engines are widely used in marine applications and are recommended.)

2. 6 cylinder overhead valve (Plymouth '60 and up. A slant-type engine--very good because of accessibility of oil pump and automatic choke.)

3. V-8 283 or 327 Chevrolet '63 and up (Good because of type of push rods and PCV system. Engine is very popular.)

4. Ford V-8 390 (Rocker arm, push rods, and lifters can be changed without disassembling engine.)

The four recommended engines provide the major types of gas, oil, and air filters. The two major types of rocker arms and valve lifters are included. Most automatic chokes are represented. The newer Ford or Chevrolet V-8, if new enough, may have the new improved combustion system. All engines should be in running order with cooling and exhaust systems.

CHASSIS:

One of the engines may be in a chassis. In any case, a complete operational chassis with engine, lights, dash, etc. is necessary. The chassis may be used for most activities if necessary. One unit requires certain types of defective tires to be mounted on the chassis.

TRAINING AIDS:

(The coding is very important because of the self-scoring test cards. The questions in the learning units are geared to the coded samples.)

Unit 5-1: A 4' x 5' board with defective belts coded as indicated:

glazed belt "W"
oil soaked belt "X"
frayed belt "Y"
cracked belt "Z"

Unit 6-1: A 4' x 6' board with a complete operational parking, turn and stoplight circuit. Use sample components from different automobiles. Some sockets must be mounted including a corroded socket labeled "Y". Sample fuses should be mounted and marked as follows:

1 blown fuse "H"
4 good fuses as follows:
9 amp fuse "J"
15 amp fuse "K"
7-1/2 amp fuse "L"
20 amp fuse "M"

Unit 6-2: A 4' x 6' board with two types of headlamp systems--a 2-lamp unit and a 4-lamp unit. Various types of retainer, spring and screw arrangements must be represented. Therefore, the 4-lamp system, for example, 1962 Chevrolet lamps on the left side and 1965 Ford lamps on the right side. The 2-lamp system should have, for example, a 1964 Rambler lamp on one side and a sports car MG type lamp on the other side. The systems must be operational with high beam indicator, on-off switch, dimmer switch, etc. A battery or transformer will be required for live testing. Each lamp should be identified by type of vehicle. The 1962 Chevrolet high beam lamp must be marked "A" and the 1962 Chevrolet low beam lamp marked "B".

Unit 7-1: Four plugs in Tote-Tray #7-1 lettered:

plug good "A"
plug bad "B"
plug good "C"
plug good "D"

Unit 7-2: Plug rack in Tote-Tray #7-2 with sample plugs lettered:

cracked insulator on plug "AA"
burned electrode on plug "BB"
good plug "CC"
worn-out electrode on plug "DD"
good plug "FF"
new plug "VV"
oil fouled plug "WW"
lead fouled plug "XX"
good plug "YY"
carbon fouled "ZZ"

Unit 7-3: A dozen or so used plugs requiring cleaning in Tote-Tray #7-3.

Unit 8-1 & 8-3: Tires mounted on the Ford chassis and in tire rack. Tires must be coded as follows:

RR should be worn from overinflation and marked "D"
LR should be worn from underinflation and marked "A"
LF should be worn from excessive toe and marked "B"
RF should be worn from excessive camber and marked "C"

Tire rack must be marked 8-3 and should be large enough to hold 12 tires. The tire rack should be equipped with a hook on which used tubes can be stored.

Tire "F" should have less than a safe tread depth (worn out)
Tire "E" should be a useable tire with normal tread wear
Tire "G" should show wear from being out-of-balance
Tire "H" should have a sidewall bulge

Unit 9: This unit requires a wood bench for batteries and a slow charger. Batteries must be coded as follows:

Battery "A" should be less than 50% charged
Battery "B" should have a bad cell
Battery "C" should be worn-out
Battery "D" should be defective with a shorted cell

Unit 10-1: Tote-Tray #10-1 must have five radiator caps marked as follows:

Cap with bad gasket "R"
Cap of the constant pressure type "S"
Cap which will not hold pressure "U"
Cap which tests good "V"
Cap of the pressure vent type "W"

Also for this unit, one training engine must have two caps fastened by a chain to the frame.

Cap which is too loose "X"
Cap which fits properly "Y"

Unit 10-4: A 4' x 5' board with used sample hoses. They must be coded:

soft "O"
brittle "P"
chipped "M"
cracked "N"
normal wear and useable "R"

Unit 10-5: A rack is required which holds 4 bottles coded:

rusty coolant "X"
normal coolant "Y"
oil contaminated coolant "Z"
water and rust inhibitor "W"

Unit 10-7: Tote-Tray #10-7 must have used thermostats coded:

heavy deposits "U"
defective valve (stuck open) "V"
cracked or split "W"
not opening properly (stuck closed) "X"
still useable and OK "Y"

Unit 11-3: A rack is required which holds eight bottles coded as shown. The cap should have a dipstick attached.

Labeled OIL WITH WATER "W"
dirty engine oil "X"
normal engine oil "Y"
Labeled NEW OIL "Z"
Labeled ATF WITH WATER "U"
Labeled NEW ATF "V"
normal ATF "R"
dirty ATF "S"

EQUIPMENT:

1 - tire machine (air operated but not automatic)
4 - 5" vises
1 - grease and oil dispensing machine (automatic)
1 - spark plug cleaning machine with plug tester
1 - 2 ton floor jack
1 - frame and bumper jack
1 - automatic lift or hoist
1 - filmstrip machine
1 - 8mm film loop machine
1 - fast battery charger
1 - slow battery charger

BENCHES AND FURNITURE:

3 - cabinets 36" high with 3 shelves each and locks
6 - benches 6' long
1 - 4 drawer file cabinet with locks
1 - shop foreman's desk (stand-up type)
1 - study carrel, 4 position
8 - stools

APPENDIX N

TOTE-TRAYS: FIRST LEVEL

POWER MECHANICS

Tote-Trays

Tote-Trays are used with most learning units and performance evaluation units. The trays should be numbered to correspond with the units. An inventory of all tools and items in each tray should be affixed to the front of the respective tray.

Unit 4-1 Wash and Polish: Car wash solution, wash unit, whitewall brush, whitewall cleaner, chamois, floor brush, paper towels

Other items needed include: vacuum cleaner, pail, and water hose

Unit 5-1 Drive Belts: Belt adjusting gage, pry bar, 1/2" combination wrench, 9/16" combination wrench, drive belt data catalog, Mobil Service Handbook

Unit 6-1 Miniature Bulbs: #1 Phillipshead screwdriver, 4" standard tip screwdriver, long-nose pliers, combination plier, socket cleaning brush, replacement bulb catalog, sandpaper

Unit 6-2 Headlamp: #2 Phillipshead screwdriver, 6" standard screwdriver, long-nose pliers, hook tool, replacement lamp data catalog

Unit 7-1 Clean, Gap and Test Spark Plugs: Plug file, wire gage, plug gapping tool, wire brush, jar of solvent, specification chart, a box of used plugs requiring cleaning (Keep a large number of used plugs available for practice work and cleaning.)

Unit 7-2 Change Spark Plugs: Hinge handle, 3/8" drive ratchet, 13/16" deep socket, 4" extension, plug rack, plug gaskets, 14m and 18m wire gage, plug gapping tool, torque wrench, air hose, blow guns, 4 wiper hoses, plug deposit and defect chart, engine spark plug specification chart, plug rack with 8 defective plug specimens

Unit 8-1 Tire Inflation: Tire gage, air hose chuck, tire pressure data booklet, valve caps and valve cores, valve core tool

Unit 8-2 Remove and Rotate Wheels: 10" screwdriver, wire brush, rubber mallet (This job will also require jacks, safety stands, lug wrench, and service or lube manual.)

Unit 8-4 Tire Mounting Machine: Tire lubricant, chalk, valve-fishing tool, valve core tool, wire brush, air chuck, valve caps, emery cloth, valve inserter (This job will also require a tire mounting machine, mounting band for tubeless tires, and air hose.)

Unit 8-5 Repairing Tires: Plug-type repair kit, tube repair kit, air chuck, chalk, valve caps, valve core tool, "ATLAS Service Guide: Tires and Batteries"

Unit 9-3 Clean Batteries: Terminal post brush, wire brush, baking soda, brush, battery post puller, battery pliers, cable end spreader, silicone spray (A fender cover is also required.)

Unit 9-4 Remove and Replace Batteries: Battery carrying strap, fender cover, zinc-chromate paint

Unit 10-1 Radiator Caps: Radiator pressure tester kit and instruction sheet, 18" wire, blow gun, 5 used caps and specification sheet

Unit 10-3 Testing Anti-freeze: Hydrometer with float, colored ball type tester, pointer type tester, combination pliers, one-quart measuring can, cooling system spec chart, anti-freeze protection chart

Unit 10-4 Hoses: 4" screwdriver, rubber lubricant and brush, combination pliers, spring clamp pliers (A drain bucket and a fill bucket are required.)

Unit 10-6 Flushing and Filling Cooling System: Combination pliers, spring clamp pliers, 4" screwdriver, 4' of 5/8" hose, a run-off hose which will fit in radiator neck, rust inhibitor, protection stickers or tags, lube chart manual

Unit 10-7 Test Thermostats: Thermostat tester, 5 used thermostats, parts catalog

Unit 10-8 Remove and Replace Thermostats: Combination pliers, 6" screwdriver, carbon scraper, putty knife, 3/8" ratchet wrench, 4" extension, 1/2" socket, 9/16" socket, gasket cement, gasket material (A clean rag and clean drain bucket are required.)

Unit 11-2 Body Lubrication: Oil can with SAE 10W oil, Door-Ease, flake graphite, multi-purpose grease, silicone grease or RuGlyde, wire rod, and jar of solvent (A floor creeper and clean rags are required.)

Unit 11-6 Lubrication: Penetrating oil in an oil can, oil can with SAE 10W oil, hand grease gun with ball joint grease, grease gun adapters, small wrench set

APPENDIX O

SAMPLE PERFORMANCE EVALUATION CHECKLISTS

PE 6-2/7-69

QPS/AIR/ABLE
Power Mechanics
DOT #915.867
Unit PE #6-2

____
Student

__________ __________
Date Instructor

REMOVE AND REPLACE HEADLAMPS

L M S
☐☐☐ Removes and replaces headlamps.

Instructor Checks:

1. Correctly answers 80% (4) of the training check questions. U | S

2. Removes and replaces a headlamp unit of the type which does not use a retaining spring.
   a. Removes and replaces unit without touching adjustment screws. U | S
   b. Handles lamps and springs safely and with care. U | S
   c. Cleans and checks wire connectors for corrosion. U | S
   d. Replaces unit with top side up. U | S
   e. Tests unit and returns to normal operation. U | S

3. Removes and replaces a headlamp unit of the type which uses a spring to hold the retaining rings.
   a. Performs all operations to criteria listed in Instructor Check #2 above. U | S
   b. Differentiates high beam-low beam units from high beam, and #2 lamps from #1 lamps, and 3-prong from 2-prong. Recognizes the relationship between the beam type, filaments, lamp numbers, and number of prongs. U | S
   c. Correctly removes and replaces retainers and retainer springs. U | S

4. Performs tasks in an appropriate amount of time. U | S

PE 8-2/7-69

QPS/AIR/ABLE
Power Mechanics
DOT #915.867
Unit PE #8-2

____
Student

__________ __________
Date Instructor

REMOVE AND ROTATE WHEELS

L M S
☐☐☐ Removes and rotates wheels.

Instructor Checks:

1. Correctly answers 80% (7) of the training check questions.	U	S
2. Removes and rotates wheels to proper position.		
a. Identifies proper specifications and diagram.	U	S
b. Loosens bolts and nuts by turning in proper direction.	U	S
c. Removes wheel without damage to hub cap or car finish.	U	S
d. Inspects each wheel for defects and injuries.	U	S
e. Places wheels in proper position in rotation pattern.	U	S

(Continued)

3. Mounts wheels applying uniform and proper tension to lugs or bolts without damage to lug threads.		
a. Cleans threads, if required, on lug bolts and nuts with wire brush.	U	S
b. Starts threads by turning in proper direction.	U	S
c. Tightens lug bolts or nuts without damage to threads with tire in secure and proper position.	U	S
d. Applies proper tension to lug bolts or nuts.	U	S
4. Performs tasks in an appropriate amount of time.	U	S

PE 10-3/7-69

QPS/AIR/ABLE
Power Mechanics
DOT #915.867
Unit PE #10-3

Student ____________________

Date __________ Instructor __________

TESTING ANTI-FREEZE

L M S
☐☐☐ Tests and adjusts anti-freeze.

Instructor Checks:

	U	S
1. Correctly answers 80% (4) of the training check questions.	U	S
2. Identifies the specifications and information necessary for accurate testing and adjustments.		
a. Cooling system capacity in quarts.	U	S
b. Quarts of anti-freeze required for a given minimum protection level for a variety of vehicles.	U	S
c. Quarts of anti-freeze required for a 50% concentration.	U	S
d. Service requirements of vehicle.	U	S
e. Number of quarts required to reach a lower level of protection.	U	S
3. Determines the freeze point or level of protection (±5°F) of a cooling system using two types of testers.		
a. Observes safety precautions.	U	S
b. Adjust coolant level following specified procedures	U	S
c. Accurately tests coolant with small (colored balls) type tester.	U	S
d. Accurately tests with standard anti-freeze hydrometer.	U	S
4. Performs tasks in an appropriate amount of time.	U	S

APPENDIX P

SELF SCORING RESPONSE CARD

Trainer-Tester Response Card

The response cards have fulfilled several important functions for the Power Mechanics program. For example, the cards virtually eliminated test grading by the instructors. Many evaluations are required by the design of the instructional program. The time requirements of grading tests would leave the instructor no time for tutoring without such self-scoring aids. The cards provide immediate feedback on all responses--a valuable teaching aid in itself. The level of difficulty is immediately available with the number of attempts clearly recorded. This in effect, permits an item analysis for not only each individual but for the group as well. Most training aids have been keyed to the cards and this eliminated many instructor checks. Cheating is very difficult when the variable codes are used.

High discrimination scoring procedures are possible when using short tests. There are teaching advantages in giving frequent, shorter tests rather than the infrequent and longer ones. However, short tests ordinarily give a very low reliability. The response card will enable an increase in the range of possible scores with a consistently greater value of the standard deviation. The suggested point scale is as follows:

1st erasure	3 pts.
2nd erasure	2 pts.
3rd erasure	1 pt.
4th erasure	0 pts.

Scoring is done by counting the blocks not erased for each item. Of course, this can be ignored for simplicity of grading.

The costs of such aids for the Power Mechanics program is computed at one dollar per student per semester. In the opinion of the ABLE research staff, the program could not function as designed without such aids. The cost is quite small compared to other less beneficial educational expenses.